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TRAIN LIGHTING.

THE subject of train lighting by electricity has once more been brought under public notice by the paper read in Section G of the British Association meeting by Mr. Smith on behalf of Mr. Timmis. The system advocated by Mr. Timmis is apparently one of a somewhat elastic and complicated character. There is a four-wire and a two-wire system, aided by certain automatic switching, &c. Two sets of batteries—one, the main set, arranged in each guard's van—the other, a number of very small accumulator cells, applied to each vehicle. The main set is for the principal and more brilliant lighting; that is, it is to provide the lighting of the group of coaches which may be said to be served by that van during the entire journey. The smaller batteries are to be used for a much less brilliant lighting of their respective vehicles when the train is broken up, *i.e.*, when the coach is being detached from one train to be attached to another. The smaller batteries are charged by the larger set, and the larger set may be charged by a dynamo driven by an auxiliary engine, or by a stationary engine employed for lighting purposes at any of the railway companies stations. This, as we understand, are the main features of the system. There are, as our readers of the paper published in our last week's issue will have observed, certain other auxiliary apparatus employed with the two-wire system, tending towards the production of the same result, viz., the bringing into operation of the minor lighting for use when the vehicle is detached.

Advocating, as we have always done, the employment of electricity for train lighting, we hail with pleasure the renewal of the subject. We have more than once expressed our opinion that railway companies will, when once it has been placed upon a solid basis, be able to light their carriages at a mere nominal cost; but it must not be forgotten that railway companies have yet to be won over to the cause. That which has been done, and which is still being done, on the Brighton line and on the Midland, as also on the Great Northern, are experiments apparently well thought out, and affording solid and stable results. The systems upon which they are worked are of the simplest character which has yet been evolved. Apparently no English railway has, so far, tested Mr. Timmis's system; so that the results of its working power, its aptitude, or its reliability, are not before us; but it is noticeable that in many important points Mr. Timmis's opinion, as expressed in his paper, differs largely from that of those well-known electricians who have devoted so much time to, and we presume gained material experience from, their extended experiments. Thus he lays it down that "the batteries must not be liable to be charged when in regular work, neither must any carriage be detained at any point to have its battery charged?" Without attempting to discuss the logic of the latter portion of this principle, we must confess we utterly fail to find any justification for the restriction laid down in the first part of it. Why the batteries should not be liable to be charged, or should not be charged when the carriages are in work, appears to us so opposed to all previous experience, and to that which seems reasonable, that we can only regard it as a principle laid down to mark the distinction between the system advocated by the author of the paper and that pursued by all who have gone before him in the matter of train lighting. This is to be regretted, for the subject is, as Mr. Killingworth Hedges remarks—and with whose remarks many will very generally agree—one of importance; and, we may add, one which will have to be fought out on logical grounds. Numerous reasons are given why a dynamo driven from the axle should not, "under ordinary circumstances," be used. This, we are inclined to think, will scarcely harmonise with the views of those in England who are still working in that direction. Doubtless, in the abstract, better results will be obtained from the auxiliary engine than from the axle; but there are otherwise many arguments in favour of the latter mode of working; at all events, it is a favourable means of introducing the form of light, for, we imagine, very few railway companies would go to the expense of fitting up a large number of engines merely to try on one or two trains. Still, although we do not, and scarcely think many others will, agree with the

reasons advanced in support of this theory, it is to be observed that Mr. Timmis does not commit himself to one system or another. He says, "under ordinary circumstances, axle-driven dynamos are most objectionable." That "every van would have to be fitted with a dynamo and also a large battery" may be the case with the system enunciated by Mr. Timmis, but that it is not so with respect to the electrically lighted trains running in this country, anyone may satisfy himself by examining any one of those trains in operation. One of the advantages claimed for the axle-driving method is, that but one dynamo van is required for the entire journey of the train. It will, we feel, be a comfort to all who are interested in this work to note the wonderful results obtained by the author of the paper with a dynamo and special engine. *Boxed in from dust and wet, no heat, no lubrication for several days when in constant work*, are results which so few have obtained that we feel bound to tender Mr. Timmis our hearty congratulations on his success.

To submit to a railway company the choice of so many methods of carrying out the lighting of their trains by electricity would, we are afraid, prove so conflicting a question as to induce them to do nothing at all. At all events, it would be to some of their officers interesting to solve some of the problems and reasons advanced in this paper for pursuing certain courses only. Thus: "The voltage used to drive them (the lamps) should be as high as practicable, because the consumption of electricity (a most important factor) is materially reduced. We find that 50 volts is the safest limit." What, we wonder, would they make of this? Can anyone say in what way the *consumption of electricity* is materially reduced by using it under a pressure of, say, 50 volts, instead of 35 volts? which, so far as we can see, is what the author wished to impress upon his hearers, or those who may study his paper. Does the author know anything of electrical units? Is he aware that the candle-power of a lamp is usually calculated at so many watts per candle, and that the watt is the product of the current multiplied by the pressure, the *ampère* multiplied by the *volt?* What, then, does he mean by: "These lamps (50-volt), which we call the main lighting lamps, consume ·6 of an ampère each, whereas a 32-volt lamp consumes over an ampère. This is a very great advantage and economy in the working of railways. The extra number of cells, viz., 26, as against 18, being far more than counterbalanced by the saving of nearly 50 per cent. of electricity (*i.e.*, cost of charging and weight of lead per cell), and the increased amount of light." Surely, if Mr. Timmis knows anything of the subject, he knows that this, in the vernacular, is *bunkum*. He ought to know that whatever is taken out of the battery requires the expenditure of certain energy or power to replace it; and whether it is 20 ampères at 50 volts, or 50 ampères at 20 volts, it is all one and the same.

Papers of this calibre are not, we fear, destined to advance electric lighting in railway trains. The arguments employed to support the system, whatever it may be, must be sound and logical. The system itself must be a clearly defined one, and in character as simple as the application will admit. There are many points in the paper open to adverse criticism, and which cannot escape the observation of those who are acquainted with the subject. We can quite understand why, if several coaches have to be lighted for any length of time—say, six to eight hours—off one set of batteries, the voltage should be 50 instead of 35, especially when it is proposed to charge the battery from a stationary installation; but we do not understand it in the way it is put forward in the paper. We agree with Mr. Killingworth Hedges in that the reduction of the light from the proposed higher power to the lower power when detaching vehicles would be a proceeding readily resented by passengers occupying the vehicle. The Midland have several of their main line trains fitted in the manner indicated by Mr. Hedges, *i.e.*, each coach carries its own lighting power in the shape of so many small accumulators. These accumulators are charged in some trains by the dynamo on the locomotive, and in others by that driven from the axle of the guard's van. As we have gathered, there is a reserve power of some eight hours in these cells, sufficient to light the train, as has frequently been done, an entire journey, but which is daily used for lighting certain coaches to and from their destination on branches in connection with the main line. The equipment consists of 18 cells, and the weight, with many other interesting particulars, will be found in Mr. Langdon's paper read before the Institution of Civil Engineers in May last. Whether 18 or 26 cells is the most suitable is perhaps an open question, but Mr. Langdon's reason for adopting this number is well known, viz., that whilst recognising the desirability of employing anything up to 50 volts, it must be borne in mind that each connection is in itself a source of failure, and that for this reason the number of connections should be reduced as much as possible, having regard to other requirements. The whole of the electric train lighting on the Midland is established on this basis; 35-volt lamps are used throughout all trains, whether local (driven from one set of batteries) or main line. As was pointed out by Mr. Langdon in his paper previously referred to, the question of pressure at which the lamps should be used is one of importance if electric lighting in railway trains should be employed to any extent, otherwise there will be great confusion when the stock of one railway is required to be attached to stock of another. We cordially commend to all who are working in this direction the desirability of agreeing between themselves upon a standard voltage for interchangeable railway stock.

CAN LONDON BE TELEPHONED FOR £10 PER ANNUM?

THE *Times* correspondence on the telephone has now practically resolved itself into a consideration of this question. It is answered in the affirmative by Mr. Bennett, who maintains that his British Association paper showed that a subscription of £8 would suffice, and by Mr. Campbell Swinton, who assumes that the National Company have, from the London service, to pay a dividend on a very large capital, and asserts that a new service of equal dimensions and superior quality could be obtained for a very small one. The National Company have taken no direct part in the discussion. We presume they know their own business best, though it would seem generally that an opportunity of setting themselves right with the public might have been worth taking. Mr. F. Faithfull Begg has taken up the

cudgels on their behalf, though they are hardly to be congratulated on the tact which he has displayed or the success attending his efforts.

We hoped, and might reasonably have expected, that the discussion would lead to some well-considered conclusions; but we are compelled to admit that so far as it has yet gone, there is little wisdom in the multitude of counsellors. The public have been led to believe that an efficient service can be given for a subscription of £8 per annum. Favourable promises are tenaciously remembered, and if not early realised, tend to check the progress of an industry. The electric light has not yet recovered from the evil done to it by injudicious and inexperienced persons, who unnecessarily promised that it should be furnished at, or less than, the price of gas, and those who, too readily promise a subscription rate of £8 for telephones, should remember that they are possibly creating a Nemesis which may mete out punishment to its creators.

We have no intention of attempting to answer the question; but in the public interest we are compelled to say that there is no experience elsewhere which will show that such a rate is, in the near future, a reasonable one to expect, though what it may be eventually, it is not necessary to speculate. It should be cheap, and will doubtless follow the usual course in that respect; but it is very necessary that the public should not be misled. No good ever comes from misleading them. Since, then, experience does not help us to a solution, we must consider the arguments of those who assert that it can be done, and done now.

On any other than an electrical subject the arguments which have been set forth would have been met and answered in the *Times* itself. Had it been for a canal or a bridge it would have been pointed out that Mr. Bennett's estimate entirely lacked the consideration of necessary detail, and that it began at the wrong end, starting with a subscription rate and working backwards to the capital outlay, instead of a careful survey and rigid estimate of capital outlay, and then a reasonable estimate of the subscription required to pay a dividend thereon. In the interest of electrical engineers it is our duty to point out that this does not meet with the approval of those who demand in their profession the rigid circumspection necessary in any other. The same may be said of Mr. Swinton's figures, which show too great a disproportion to suggest reasonable care having been taken. And when Mr. Swinton argues that the company's patents being dead their value is at an end, we must also point out that in the electrical business, as well as in any other, it is recognised that the protection afforded enables a patentee to develop a business as well as to make profits on it while the patent is in force. We can see no good whatever in shutting one's eyes to the fact that the Telephone Company has developed an exchange business, and is the only organisation in London which has been able to do so. Whether its business be good or bad, firmly or loosely held, may be matter of individual opinion; but it has that business, and until it shares that position with a competitor or competitors it cannot truly be said that all capital representative of patents must be left out of account.

On one point all are agreed—that the telephone service of London should be extended, improved, and, if possible, cheapened. Disregard of these legitimate expectations by the existing company will infallibly tend to a service being undertaken by others. We have found it necessary to point out the want of practicability in the schemes and views presented in the *Times* correspondence. But these schemes and these views are capable of modification. This should be recognised by the National Company, and it should be equally recognised by contemplating competitors, that though there has been a good deal of royalty about telephones, there is no royal road to telephone exchange business, and that competition in such work is not easily comparable with other enterprises. A recognition of these facts will tend to public benefit.

In connection with this subject we would refer our readers to the letter of "Telephonist," which appears in our Correspondence columns.

An Italian Improvement in Accumulators.

PROF. GIOVANNI GAUDINI has recently proposed the following improvement relating to accumulators:—The electrodes are formed of a mixture of lead oxide and small pieces of carbon, and they are separated from each other by porous partitions. These porous partitions may be either straight or curved, and are manufactured from any solid or gelatinous (*sic*) material capable of resisting the corroding action of sulphuric acid. The electricity is collected on both sides of the porous partition by means of plates, strips, bars, or rods, made of lead and immersed in the mixture of lead oxide and pieces of carbon. The addition of these pieces of carbon to the lead oxide is made for the sake of increased porosity; moreover, it is stated that it accelerates the formation, and at the same time increases the capacity of the active material relatively to its weight. Coke or retort carbon is generally used, and the mixture with lead oxide is filled into porous vessels, each containing a plate or rod of lead; these are introduced into other vessels containing the same mixture and also a strip of lead. A thin layer of lead oxide is spread on the top of the mixture, which is renewed during the formation or discharge of the accumulator. The exciting fluid used is the usual solution of sulphuric acid.

An Improvement in Smelting and Casting by Means of Electricity.

AN improvement in apparatus for smelting and casting has recently been developed by Eduard Taussig, of Bahrenfeld, the chief feature of which is that the operations are conducted in a partial vacuum. The smelting furnace is connected with the casting apparatus and the mould in such a way that they form an air-tight enclosed whole, the separate parts of which are easy of access. The smelting of the metals in the furnace is effected by means of electricity, the furnace being placed in the circuit of a dynamo. The current is directly conducted through the metal to be melted, which is used in a granulated state, by means of electrodes which are made of the same metal as that which is to be melted. The electrodes may, however, be made of a more refractory metal. The resistance thus introduced into the circuit between the electrodes produces a very high temperature. The electrodes are in the shape of plates fixed on the end walls of the furnace, and are insulated. They are further imbedded in the walls of the furnace, and connected with the positive and negative conductors. The discharge pipe for the molten metal is connected to the casting moulds, which run on small rails. The moulds are partially exhausted of air by means of an air-pump, and the furnace is also connected with the suction pipe of the pump. Most of the air and gases given off during the smelting are thus drawn off

and expelled. Glass-covered openings in the furnace enable the progress of the smelting operation to be inspected, and there are also pressure gauges attached which indicate the amount of vacuum in the furnace and the mould-box. This plan is stated to greatly facilitate both smelting and casting.

The Lauffen-Frankfort Transmission.

THE tiny little village of Lauffen on the Neckar has become historical. But for this electric transmission experiment, the Exhibition would have had little to make a noise about, the Congress would not have been attended by a tithe of the number actually attending; at any rate, we imagine that very few foreigners would have been present. Lauffen-Frankfort is in everybody's mouth; it is *the* attraction, it is *the* subject upon which most questions are asked and fewest answered. We are in a position to state that the multiphase motor in the Exhibition is working several hours every day pumping the water for an artificial waterfall. It works very well indeed. Every night there are in use between 900 and 1,100 incandescent lamps of 16 C.P. and 65 volts, fed from the transformer, which derives its energy from Lauffen. The E.M.F. used is 15,000 volts, and it is the intention to work it up to what was originally intended. The total power transmitted up to the present has not exceeded 110 E.H.P.

Tests with the Safety Appliances on the Lauffen-Frankfort Electrical Transmission.

A FEW days ago the Government officials tried the safety appliances on the overhead conductors, carrying a current of 15,000 volts. Disturbances which are likely to take place, such as the breaking and falling of wires, or their coming in contact with each other, through natural causes, have been made intentionally. Directly two of the high-tension wires touched, a short circuit occurred, which fused the cut-out, and discontinued the flow of current. On breaking one or two of the high-tension wires, the "minimum cut-out" worked, and stopped any further generation of current. The ends of the wires were next dropped upon railway rails fixed to the earth, and the minimum cut-out again stopped all further flow of current. The wires could be picked up again without the least danger.

Inspection of the Installations at Lauffen.

ON the 14th inst. a select party of engineers and professors, under the guidance of the directors of the Allgemeine Elektricitäts Gesellschaft and of the Oerlikon Works, were invited to visit the generating station at Lauffen, 110 miles distant from Frankfort. Among the few privileged guests were Prof. W. E. Ayrton, Dr. S. P. Thompson, Mr. W. H. Preece, Mr. Gisbert Kapp and Mr. A. Reckenzaun. The official tests as to the efficiency of the plant and other data will not be obtained until the jury has had an opportunity of making all the necessary experiments at both ends of the line. For this purpose Prof. Weber is now making arrangements, and the world will probably soon know the results of these most interesting developments in the electrical transmission of power.

A Suggestion from China as to the Origin of the Magnetic Needle.

A CERTAIN "Meter" has been enquiring in the columns of the *English Mechanic* for information as to the invention of the mariner's compass. If there is any authentic information to be obtained anywhere, surely it ought to be from China, the country to which legend or history (which is it?) ascribes the discovery of this valuable aid to navigation. "Meter" quotes a writer in the *North China Herald*, who says that the Chinese certainly did not learn the properties of the magnetised needle from any other country. They found it out for themselves, though it is impossible to state who it was who first observed that a magnetised needle points north and south. The writer, presumably a native of the Flowery Land, suggests that it came about in this way. The Chinese have in their country boundless (*sic*) tracts of ironstone, and among these no small portion is magnetic. Every woman requires a needle, and iron early took the place of the old stone needle, and were commonly used before the time of Ch'in Shih-huang, that is, more than twenty-one centuries ago! Whenever a needle happened to be made of magnetic iron, it might reveal its quality by falling into a cup of water, when, for example, it happened to be attached to a splinter of wood. It came in some such way to be commonly known that certain needles had this quality. The great producing centre for magnetic iron is T'szchou, in Southern Chihli. This city was very early called the City of Mercy, and the magnetic stone produced there came to be known as the stone of T'szchou, and so *t'szshih* became the ordinary name for a magnet. Later, the Chinese began to speak of the city as the "City of the Magnet," instead of calling it the "City of Mercy." The polarity of the magnetic needle would become known to the Chinese of that city and its neighbourhood first, and the first person who noticed the polarity would be some intelligent observer who communicated the fact as an unaccountable peculiarity in an age when omens and portents were diligently sought for in every natural object and phenomenon. The earliest author who mentioned the "south-pointing" needle lived in the fourth century B.C. The rest of the communication is too long for notice, but the writer goes on to trace the development and use of the magnetic needle in China, and seems to speak from an intimate acquaintance with the records of the Celestial Empire.

The Factors of Energy.

THERE is an interesting paper in the *Zeitschrift für Physikalische Chemie*, by W. Meyerhoffer, on what he calls the factors of energy, which is worth a brief notice in these pages. Any form of energy can be decomposed into two factors. Thus, for example:—

$$\text{Electrical energy} = \text{quantity} \times \text{potential}.$$
$$\text{Energy of gases} = \text{volume} \times \text{pressure}.$$

Meyerhoffer gives the general equation:—

$$\text{Energy} = \text{content} \times \text{potential};$$

the word "content" being, perhaps, the nearest English equivalent to the German term "inhalt," which he makes use of. He then enunciates the following principle, namely: "The energy-contents of the ultimate particles of matter are equal." He proceeds to show that nearly all stoichiometric regularities are particular cases of this rule, and that all known methods of determining molecular weights are based on one and the same principle, that, namely, of finding what masses possess the same energy-content. The second law of thermo-dynamics is next discussed, and the conclusion is arrived at that in its ordinary form it is *untenable*, because there is no fundamental difference between heat and any other form of energy; the apparent distinction resting merely on the fact that we cannot obtain zero-potential (the absolute zero of temperature) in the case of heat-energy, whilst this is possible for other forms, as, for instance, in electrical energy. The remainder of the paper is taken up with some considerations on the condition of equilibrium in general, and the author concludes by identifying his "heat-content" with the so-called "calorique" of Carnot." He also strongly contests the existence of energy as a substance. If our readers are further interested, they will find the original paper in the *Zeitschrift für Physikalische Chemie*, No. VII., p. 544, where it occupies upwards of forty pages.

ELECTRIC RAILWAYS FOR RAPID INTERCOURSE BETWEEN CITIES.

By CARL ZIPERNOWSKY.*

AFTER some introductory remarks on the agreeable character of rapid electric travelling, the speaker passed on to the real object of his discourse—the project of a rapid electric line from Vienna to Budapest—and remarked with reference to the system to be adopted, that from the nature of the case, the traffic on such lines cannot be worked with long trains at considerable intervals, but with small trains conveying only a limited number of persons, or better with single carriages which follow each other at short intervals.

This arrangement is necessitated not merely by the circumstance that a frequent communication between the terminal points is more important for the general traffic than the simultaneous transmission of many travellers—which is not the question—but by the technical regard to the greatest possible decrease of the power required per train, and on the most uniform possible distribution of the consumption of power over the whole line.

The less the weight of the train, the smaller the electromotors and the less the consumption of power per train, the simpler, more certain and cheaper will be the conveyance of the current. The smaller the units brought into intercourse, the safer and the more profitable will be the undertaking, because the fluctuations of the demand of the traffic in the course of a day can be estimated, because it will be possible to adapt the arrangements to these fluctuations and to maintain always a favourable proportion between dead weight and useful weight. Small units of trains at short intervals involve the further advantage that the lead will be more uniformly burdened than if long, heavy trains were despatched. The demand on the leads and the machinery will be more uniform and the installation will work more rationally.

The increased demand on the staff in working tram lines falls into the background in comparison with the circumstance that an irrational working of the installation would occasion considerably higher working expenses.

These are the reasons which induced us to take tramway working as the basis of our project.

In order to pass to the construction of the carriages and to investigate the special case in question, the Budapest-Vienna project, it was previously necessary to determine the speed of the carriages, the shortest intervals at which they can follow each other, and to fix the number of travellers, as well as space of the carriages required, and on the basis of the the sizes and weights thus arrived at, to arrange the shape of the carriages, the power necessary for their propulsion on rails laid very carefully, and thence to deduce the strength of the electromotors, the total weight of an occupied carriage, and in accordance therewith the kind of the upper structure (*i.e.*, the parts of the carriage above the axles) and the manner of carrying the current.

In all these considerations we have sought as far as possible to meet the conditions of a general traffic, and in the special case which we have elaborated, we have to some extent created a general model serviceable for an entire continental network of railways.

As for the speed of travelling, we wish to reach the maximum which is practicable with a construction of rails suitably modified, and a propulson by simple adhesion.

The speed can be increased only in as far as the tenacity of the materials employed, especially the wheels, will permit.

The limit lies, as calculation shows, at about 250 kilometres per hour. The rotary speed of the wheels with a diameter of 2½ metres is so considerable (near 70 metres per second) that the resistance of their tires to rupture in consequence of centrifugal force becomes a decisive factor for construction and calculation. It is found that even with disc-wheels the rotatory speed of 70 metres per second cannot be exceeded, as even the least frangible materials at our disposal do not present sufficient security against bursting.

Adhesion also presents a limit up to which we may push the velocity of travelling so as to effect the propulsion of the carriage with due security. The limit depending on friction, cannot universally be fixed with precision. The gradients, the nature of the materials, the weather, &c., vary widely; the pressure of the wheels fluctuates less. It is, therefore, not possible to find a velocity up to which working by simple adhesion is still possible, and we are therefore compelled to adopt an approximate calculation based on the highest possible gradients and other relations concerned.

As the "out-running" of the wheels, *i.e.*, the difference which appears on observing and comparing their revolutions with the distance actually traversed, and still more the "skidding" of the wheels, is very hurtful and injures the safety of traffic on account of the wear and tear of material, and the deformation of the tires, in determining the duty which is imputed to adhesion, we must go to work cautiously, avoiding "out-running" and skidding, or in other words we must determine the limit fixed by adhesion.

Calculations of this kind show that on a horizontal surface with wheels of 2 to 2·5 metres in diameter we may travel 250 kilometres per hour without difficulty. These figures have naturally only a very general value, as they depend on the weight of the carriage, the number of the axles, the diameter of the wheels, the manner of propulsion, &c. We cite them, therefore, merely to show the speed to which we have adapted our railway system. We assume that the maximum speed of travelling which can be reached by single carriages, rolling on rails, is about 250 kilometres on a level and 200 kilometres on an incline.

The intervals between the trains are arranged according to frequency of the traffic and the capacity of the carriages.

Here also there is a limit depending on the safety of traffic. No train must follow a previous one so closely that, in case of any irregularity in the former, it cannot be stopped in time. The possibility of stopping and of signalling is insured by the arrangements which will be established along the line for this purpose.

If in an electric railway with rapid traffic we were to adopt the same signal appliances as are now in use at speeds up to 100 kilometres, there would be a risk that at such an accelerated velocity which makes hearing and sight more difficult and uncertain, the signals might fail in their action. A perfectly novel system of signalling adapted to high velocities must therefore be applied.

We must also provide for the chance that these signals are not seen from the train, and care must be taken that in this case the various watchmen along the line may be able to stop any carriage without further signalling, which in case of an electric line, may be effected by means of cut-outs.

The shortest interval is determined by the condition that a carriage when its current is cut off can run only to a certain distance by means of *vis viva* or a possible incline. This distance for the sake of safety must be maintained beween any two successive trains even when at a standstill.

The smallness of the interval depends upon the effectiveness of the brakes at the disposal of the conductor, and upon the certainty with which he is made aware of any unexpected cutting off of the current.

It will be understood that the determination of the minimum interval between trains can be effected only in connection with the brakes and stoppage apparatus, and must be placed below 10 minutes.

The minimum interval will be admitted in the train-tables only at those times of day when the traffic is most crowded. Local conditions are here decisive.

The capacity of the carriages must be such that all passengers may find room even when the traffic is most dense. Still the carriages, from reasons already mentioned, must not be too large and heavy. Hence the combination of a number of carriages into one train seems inadmissible.

The arrangement of the carriages will be a difficult matter until practical experience has shown to what extent the travelling public will make use of this new kind of conveyance. We believe it may be assumed that with carriages having 60 seats, at intervals of 10 to 60 minutes, the demands of traffic can be met, since during the busiest time more than 200 persons can be forwarded hourly, which is a large demand, and since there will be no difficulty during the slackest times of the day in reducing the capacity of transport to 50 persons per hour.

Besides the conveyance of persons, the despatch of the mails must be taken into consideration in any project for accelerated transition. It cannot fall within the scope of such an undertaking to transport any class of goods beyond the personal luggage of the passengers, since the freights calculated on a unit of weight would far exceed the value of such an acceler-

* Read before the International Electrical Congress held at Frankfort-on-the-Main, September 8th, 1891.

ated transmission, even in case of more bulky travelling luggage.

Nevertheless the undertaking must be in a position to forward the heaviest luggage of travellers to its destination. Hence we pre-suppose that at those hours of the day when the traffic is slackest special carriages should be dispatched at a speed of about 100 kilometres per hour, fitted with less powerful electro-motors, but containing more room for luggage and post packages.

The entire arrangement of the electric part of the installation is that the central station is placed at about 60 kilometres from Budapest, and the same distance from Vienna, therefore about the towns Banhid-Zurndorf.

From this central station there pass high tension currents of about 10,000 volts along the entire line, and from these leads, which are intended to be aerial, there branch off currents to the secondary stations which serve at the same time as watchmen's houses.

In these secondary stations the high-tension current is either used as such, or is converted to a lower tension by transformers.

It will entirely depend from the experimental results with the motor of the carriage which kind of current deserves the preference.

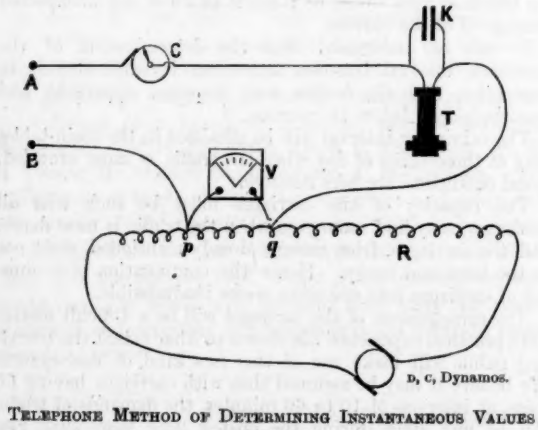
(*To be continued.*)

A METHOD OF DETERMINING INSTANTANEOUS VALUES OF A PERIODIC E.M.F.*

By RALPH D. MERSHON.

THE methods heretofore in use for measuring instantaneous values of E.M.F. in the determination of the wave form of a periodic E.M.F. are those employing the ballistic galvanometer and electrometer. Some time ago another method suggested itself to me, which by the kindness of the Westinghouse Electric and Manufacturing Company, through Mr. Chas. F. Scott, the assistant electrician, I have been enabled to thoroughly test, and have found both convenient and accurate.

The needle of a galvanometer in series with a contact device and the periodic E.M.F. will, if its time of vibration is sufficiently great, be steadily deflected by the succession of impulses it receives. If there be placed in series with the contact device, galvanometer and periodic E.M.F. a steady E.M.F., which at the instant of contact opposes the first, and it be varied until the galvanometer deflection is zero, its



TELEPHONE METHOD OF DETERMINING INSTANTANEOUS VALUES OF E.M.F.

value will be that of the periodic E.M.F. at the point on its wave for which the contact device is set. This mode of procedure is unsatisfactory, however, for small voltages, as in that case the deflections on an ordinary low-resistance mirror galvanometer in fairly delicate adjustment are small, even though there be a condenser of several microfarads in parallel with it. A plan much better both as to accuracy and convenience is that of replacing the galvanometer with a telephone receiver.

In the diagram let A B represent the terminals of the source of a periodic E.M.F. whose wave form is to be determined. C is the contact device attached of course to the shaft of the generator furnishing the periodic E.M.F. T, is a telephone receiver which may have in parallel with it a condenser, K. R, is a resistance in series with a direct-current dynamo or storage battery; a part of R consists of a slide-wire resistance along which the sliding contact, p, can be moved. V, is a direct-current voltmeter. Suppose the sliding contact, p, to be moved to q. The contact device, c, being set for some point on the E.M.F. wave other than zero, there will be heard in the telephone a succession of sharp clicks—one for every revolution of the contact device. If p be moved away from q, and the fall of potential between the points p and q on the resistance, R, be in such a direction as to oppose that between A and B at the point on the wave for which the contact device is set, the loudness of the clicks heard in the telephone will diminish with such movement, and a place may be found at which they are no longer heard, and beyond which they become again audible. This place corresponds to an approximate equality of the steady and the unknown E.M.F., and the reading on the voltmeter gives to a certain degree of accuracy the required instantaneous value of the periodic E.M.F. For a more accurate determination we must adjust to zero sound by moving p up first from one side of the zero point, then from the other. In general the two settings obtained in this way will not coincide, since there is a limit to the current which can be detected by the telephone, and the point midway between them on the slide-wire resistance must be taken as the true setting. The voltmeter reading gives them the true value.

The delicacy of the telephone is much increased by placing in parallel with it a condenser. Great delicacy is not at all times, however, desirable. Should the belt driving the generator of the periodic E. M. F. have bad joints in it, or vibrate much, the variation in speed due to either or both of these causes can be plainly noted in the telephone, as some of the clicks will be louder than others. With a delicate telephone it will probably be the case under these conditions that no point can be found at which there is no sound; whereas, if the instrument be less delicate, we may find two points of zero sound and interpolate as explained above. Hence, in some cases, it is desirable to diminish the delicacy of the telephone by putting resistance in series with it. There is, practically, no limit to the accuracy with which settings can be made with the proper form of apparatus. Using an ordinary Bell telephone receiver, it is easily possible to make settings to $\frac{1}{100}$th of a volt.

The apparatus for the method is simple. It can be put in compact form, and thus be always available at an instant's notice, as it requires neither adjustment nor calibration.

* *Electrical World*, New York.

A NEW FORM OF RANGE FINDER FOR USE WITH MODERN SEACOAST GUNS.*

By LIEUT. GEORGE L. ANDERSON, of the Electrical Laboratory, U.S. Artillery School, Fort Monroe, Va.

THE modern seacoast gun is an expensive piece of machinery to construct and operate. As employed in our harbour defences or on board the new naval ships, it serves to fire, as a rule, not more than 300 pounds. The wear and tear on the gun and its carriage, the original expense of the projectile, charge and minor items make, in these days, the cost of delivering a single projectile by any powerful and self-respecting nation about $450. Economy alone suggests, therefore, that the piece shall be carefully aimed, and that means must be found to ascertain quickly and accurately the distance to the object—fixed or moving—aimed at.

A still more important consideration is effectiveness of fire. Future operations are destined to be short and decisive owing to the improvements in material, so that exact knowledge of the enemy's position at the outset and during the fight will be more strongly demanded than heretofore

Artillerists have accordingly sought to devise some method of ascertaining readily, and so far as practicable, automatically, the bearing and distance of any desired object—fixed or moving—from the gun, or of locating its position in some simple manner upon a chart of the harbour or other field. Such a method, if simple, would also prove serviceable to them in operating submarine mines. The result has been a great variety of range or position finders, to be found now for the most part in the museums or the scrap heap.

An effective method, early employed on land, consisted in placing at the extremities of a suitable base line two azimuth instruments, by means of which the angles to any given object was measured. The readings were then signalled to the persons at the gun, who plotted the courses on a map of the harbour and thus located the object. A scale of the map gave the required distance, and, when the signalling was performed by telegraph, the whole operation occupied less than one minute's time. The plan when carefully conducted was found in every day practice to locate any position with sufficient accuracy. Yet the precision depends upon the skill and coolness of each of a half dozen persons, and it is not thought the method would find much use in time of war.

To render as far as possible the foregoing method automatic, the Siemens Brothers brought out several years ago their "distanzmesser" in which two light horizontal arms, 20 inches long, swept over the map on the plane table—each one keeping constantly parallel to the axis of the telescope with which it was connected electrically. Either arm was moved by the usual step by step contrivance driven by currents induced by a magnet, whose motion turned the telescope. If the telescopes at the ends of the base lines were continually directed upon a moving vessel in the harbour, the two arms of the plane table turned with them and by their intersection indicated the vessel's position on the map in a continuous manner. Only two observers were required, and the system was sufficiently automatic. But the apparatus, finely executed like all the Siemens' work, was costly, complicated, and easily disarranged. The failure of either arm to remain parallel to the axis of the telescope was not easily discoverable.

Other range finders on the Siemens principle using the make and break direct current or the induced have been tried, but they have proved too complicated, expensive, and uncertain in action.

The Watkins range finder adopted in the British service is essentially a depression instrument requiring a vertical base line not always obtainable, a correction for the height of the tide and a clear view of the water line on the vessel, which would frequently be hidden in smoke.

The Austrians use the camera obscura, which requires only a single observer, and which is so simple as to suggest its employment in this country as a check upon whatever better method may be adopted to locate objects in our harbours.

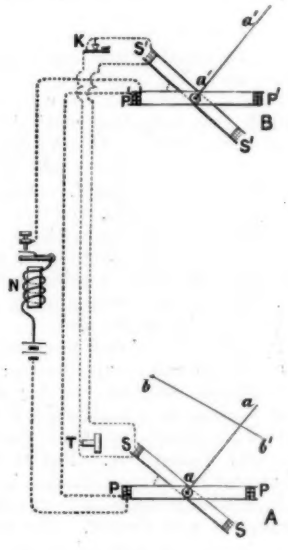
Of all the various devices thus far suggested, the range apparatus of Lieut. A. B. Fiske, U.S. Navy, is most original and interesting. It is constructed and operated upon the plan of the Wheatstone bridge. There is no complicated mechanism to adjust, and it is fairly accurate within a large range of distances; it can be manufactured cheaply, it will withstand the rough usage of service, it requires a short base line, and seems to be admirably suited to service on board ship. Several Fiske range finders have already been purchased for the Government service.

The resistance of the arms of the bridge is small, and yet we have not heard that there is a liability to error or uncertainty in the readings of the instrument, due to slight changes in the connections between the arms or to unequal heating or slight injury to the bridge wire. The inventor has, doubtlessly, considered the advisability of using larger resistances in the arms by replacing the slight turn of the bridge by a great number of small resistances joined in series and allowing the slider to move over the usual brass contact pieces.

A new form of range finder, which is here proposed, involves the principle of the Hughes induction balance as modified in the teleinductor. Balance is obtained by a motion of rotation instead of translation. It has no delicate mechanism, and it dispenses with the troublesome galvanometer. It is, moreover, simple, inexpensive, and may be brought to as high a degree of accuracy as may be desired, A full description of the instrument is not given, but the principle of its construction will be readily understood by all interested in the subject from the accompanying diagram:

P P and S S are primary and secondary coils, respectively of circular or other form, located at station A, one extremity of the base line. One coil has a smaller diameter, so that it may revolve inside the other about a vertical axis, lying in the planes of both. S S may, therefore, occupy any position from 0 degrees to 90 degrees to P P. *a a* is a light pointer attached to S S, perpendicular to its plane, and moves with it over the face of the map, which for simplicity of description we shall suppose in this case to be located at station A. At station B, the other end of the base line, P′ P′ and S′ S′ are respectively primary and secondary coils similarly constructed to those at A, or so made as to have the same coefficient of induction. A′ A′, perpendicular to the plane of S′ S′, is the axis of a telescope, whose motion in azimuth carries, in the case here shown, coil S′ S′ with it.

The two primaries, P P and P′ P′, whose planes are kept parallel to each other, a battery, and a buzzer, are joined in simple circuit as shown. The two secondaries, S S and S′ S′, a telephone at A, and a closed key, K′, are connected in simple circuit in such manner that the current induced in the secondary at A is opposite to that induced in S′ S′ at B. It is evident that whenever coil S S is moved by hand to occupy a position parallel to S′ S′, the buzzer being set in operation, all noise in the telephone will cease and the observer at A will know that the pointer, *a a*, is parallel to the vertical plane through the telescope axis, *a′ a′*.



b b is a pointer like *a a*, sweeping over the surface of the map and keeping parallel with the motion in azimuth of the axis of the telescope, *a b*, A, with which it is connected mechanically. The point on the map where *a a* and *b b* cross will then represent on the map the object in the harbor to which the telescopes at the ends of the base line are directed, if we may suppose the surface to be a plane area.

The secondary at A, as here described, should be made to revolve from 0 degrees to 90 degrees in the direction, as at B. Both secondaries may, however, revolve from 0 degree to 90 degrees in the other direction if the observer at B, by means of key K, so signals to A. The best positions are from 45 degrees on one side to 45 degrees on the other, and these may be used if 90 degrees give sufficient range, as would be the case in most instances.

The battery power may be all that the contact points of the buzzer will admit, and therefore considerable. Two telephones, having the lightness and distinctness of instruments manufactured abroad, should be employed. These are connected with each other by a metal strap which holds them tightly to the ears of the observer at *a*.

Two observers only are actually necessary. Three or four observers and essentially a duplicate of the plant above described will be required if the map is desired at any point other than the extremity of a base line. To simplify the

description four wires are here shown connecting *a* and *b*. In practice it will be found preferable to ground one of the circuits so that three wires serve equally well. Or if both circuits are grounded, two wires only will be required.

The object of this article (in *Electrical World*, New York) is to show how readily the induction balance lends itself to locate the position of a distant object at sea rather than to give a complete description of the instrument.

STEAM BOILERS FOR ELECTRICAL INSTALLATIONS.

BY W. H. BOOTH AND FRANK B. LEA.

IT has been many times remarked that the dividends of any electric light or power concern are to be sought between the coal pile and the belt. This leaves out of question altogether the still unsettled and somewhat vexatious problem of conducting mains—not a few of the expenses that ought to be profits being incurred in this direction—but still the statement thus made possesses a very strong substratum of truth, and its importance cannot be too much emphasised.

And yet, of all the processes necessitating the use of steam power in some form or other, probably not one in the whole history of engineering has laid under contribution a more diversified range of steam generators than has the production of electricity for employment in lighting or transmission of power.

Portables, semi-portables, semi-fixed (what the difference is between these two would puzzle more than the author of "Tweedledum and Tweedledee"), multitubular loco. types, marine boilers, tubular boilers with steam drums; Lancashire, Cornish, externally fired, vertical—anything has been good enough to use with engines for driving dynamos, so long as pressure in the first place could be kept up for a sufficiently long time, without regard, secondly, to the coal consumption. These two factors, however—now that the production of electrical energy has settled down into an art that is understood—are causing the adoption of several more or less prominent types of boilers as being on the whole most suitable for the purpose; and the reasons for this can be set forth accordingly as two in number also.

For the first few years of electrical progress, those engaged in it had more or less to make experiments; the whole art itself was in a chrysalis condition, and for the purposes of demonstration or working on a small scale, it was practically immaterial whether the boilers used three pounds of coal, or thirty, per indicated horse-power. But now that electric lighting is a business of strictly commercial character, the coal bill enters into balance sheets in every case, and usually forms a very important part thereof. The first reason, accordingly, for adopting any particular type of boiler for electric lighting is, that such type burns less fuel than others; it is more economical in working for a given output.

The second reason is of a somewhat less permanent nature; it is dependent upon the conditions of public demand for the products of any electric light station. That is, the requirements of electric light users necessitate the employment of boilers which are rapid and plentiful steamers. The greatest demand for light is compressed into a space of some four or five hours per day, between 5 and 10 p.m.; and—assuming the supply is in all such cases *direct*, without the intermediary of storage appliances, secondary batteries or accumulators—the boilers must be of a type that will ensure plenty of dry steam at short notice. Of course, as the demand for a supply of current increases, or rather, as the opportunities for using current become more numerous, say in the direction of electric motors, the supply will be spread more evenly over the whole day, and the question of rapid steaming will not then prove so important in deciding upon the type of boiler to employ as will, for instance, the superior capacity of steady working over a long time. This applies to electrical installations of all kinds, whether public or private; for it is just as important that a private individual should get all he can out of his machinery, as it is for a company supplying the public with electric energy from a large central station.

So far as the latter are concerned, *i.e.*, central electric light stations, there is, of course, another reason still which has operated in the direction of specialising the types of boilers most available. The powers required are so very much in excess of those used in the early stages of lighting, that there is necessary something more than a mere reduplication of boilers. What seems to be wanted is an increase in the dimensions of steam generators—or, any way, an increase in their output—whilst at the same time the cost of operating them, *i.e.*, the cost of labour (and consequently the number of furnaces) is kept the same, or is not proportionately increased.

Such qualities are, of course, claimed to be present in several of the types of boilers that are used most widely for large powered installations, and doubtless they are all equally serviceable (or nearly so).

It is, however, a point that should be kept in constant view by boiler makers, viz., how far the cost of working a number of boilers may be decreased by increasing their individual dimensions consistent with safety and good workmanship; the total output in both cases being the same.

The question resolves itself into one of ascertaining the minimum number of furnaces that can be employed for a given total output of steam power.

Leaving now any further discussion of general principles, we may proceed to examine the various types of boilers used or usable for electric light work.

From what has already been said, it would appear as though the feeling of insecurity of tenure which characterised all early electric installations has had, in common with the prevailing conditions of public demand for electric energy, so strong an influence on the steam department of electric lighting, as to a very large extent determine the character of the permanent plant of even large undertakings. This is evidenced by the extended use of the semi-portable locomotive type boiler, combined very often with an engine upon the same foundation plate.

That the boiler of the locomotive is an excellent one for its duty, few will deny; but it is by no means a rational corollary that the locomotive type of boiler is equally good when applied to stationary work, as it is when on the rails, or even over the keel of a torpedo boat. The conditions are so entirely different, that only a very superficial observer would argue that what does well in a travelling machine, must do equally well at rest. The narrow water spaces of the locomotive boiler are not the best calculated to promote water circulation, and so there is danger of the plates becoming overheated; but when running over a rail more or less uneven, or being rolled even in a comparatively smooth sea, the vibration and swilling motion no doubt are powerful factors in keeping the plates free of steam, and in water contact.

The locomotive type of boiler, too, is, in respect to the question of perfect fuel combustion, essentially a forced draught boiler, and when worked with an ordinary chimney draught, especially with the little iron chimney of small height so usual in temporary installations, it is not being treated in a fair manner.

Where boilers are of such a type that they produce smoke, complaints are sure to be made of the nuisance which they cause, and either there then arises the necessity of burning expensive smokeless fuel, or else a costly series of trials of nostrums begins, though it never ends.

Now the locomotive boiler to be smokeless and economical with ordinary bituminous fuel, should have a quick draught and a brick arch, and, when stationary, should have much wider water spaces than are usual in its proper sphere.

When thus designed in accordance with the conditions which will accompany it, and worked—as it should be—briskly, such a boiler will have a virtue which is, for instance, lacking in the vertical type: it will have a large body of water in it. Further, though the ebullition will be violent at and near the firebox, there is considerable length of barrel in which to deposit entrained water, so that the steam supplied to the engine may be dry.

In the vertical boiler neither of these conditions is present.

The mass of water is small, and as steam rises up the narrow water spaces it carries with it very much water direct to the steam pipe. This action is intensified, first, by reason of the very limited distance from the water surface to the steam pipe; secondly, by the very limited area of the water surface from which steam has to escape; and thirdly, by the small volume of the steam space which must vary in its

pressure with every stroke of the engine, and cause irregular outbursts of steam. Hence the advantage of high-speed engines for boilers of insufficient capacity. It is, however, seldom the case that vertical boilers are at present used for anything but small installations of a portable character. With water tube boilers of the type now usually constructed with sloping pipes, there appears no reason to doubt the fair circulation of their contained water, nor the dryness of the steam they produce when the steam-drum is not too full of water. The water tube boiler has, however, the serious disadvantage of being a smoke-producer. Its considerable employment in the United States may be traced to the fact that it has been used so much with smokeless anthracite.

With bituminous coals, however, it tends to be a smoky boiler.

The reason for this is simply that the products of combustion and gas distillation rise straight from the surface of the grate, where they are produced, directly amongst the water tubes above where they are cooled down before combustion could be completed even if the conditions for perfect combustion were present. They are not present. The perfect combustion of bituminous coal requires four main conditions, viz. :—

1. The admission of fresh air above the fire surface over and beyond that which passes through the fire by the grate.
2. The thorough mixture of this fresh air with the evolved hydrogen gases of the coal.
3. A temperature usually understood not to fall below a minimum of 1,000° Fahr.
4. A certain free unimpeded space in which combustion may complete itself after ignition.

To give point to the foregoing, we will show how these four conditions are fulfilled in the Lancashire type of boiler. The fire is usually of considerable length. In the furnace door the admission of fresh air is provided for by an air grid giving something like 1½ square inches of opening per square foot of grate surface. In travelling over the fire such air is mixed with the gases evolved, and by the time the bridge is reached the mixture will be heated to the point of combustion. This takes place at the contraction of the bridge opening, and completes itself in the iron flue beyond. Practical combustion is but little understood, even by those who should make it a subject of study. The combustion of impure coal gas, diluted as it is with carbon dioxide from the solid carbon burned *in situ* by the air which passes through the grate, is more or less uncertain. It approaches more or less closely to the state of a flickering flame, such as that seen above any newly-coaled house fire. Very little serves to put out the flame, and we have known a case where two boilers, in every known respect exactly similar (with the exception that in one of them there was an extra water tube close up to the bridge), were yet entirely different in behaviour. The extra water tube caused the one boiler to be smoky, whereas the other was free from smoke, and yet the smoky boiler was cured by bringing its bridge some 3 inches clear of the extra water tube, the shock of meeting which by the newly-ignited gas put the flame out.

When the draught is sufficient to draw in the necessary fresh supply of air at the doors, the Lancashire boiler may be made smokeless, but it should contain no water tubes near the bridges. It may, indeed, be a matter of wisdom to entirely discard cross tubes in the flues of any Lancashire boiler. Of course this is contrary to general practice, but it has never been conclusively shown that such tubes are a source of either strength or economy, while there have been experiments showing to their disadvantage, and they are decided obstructions to draught, to cleaning, to inspection and repairs, and a source of increased first cost as well as a complication added to a boiler, the special feature of which is simplicity and accessibility.

This boiler is essentially a boiler for permanent work, and deserves more consideration than has yet been accorded it by electrical engineers, who have, so far, adhered to boilers of a more or less portable type.

As we have already in a recent article under the head of "Rope Driving" fallen back for illustration upon the steam engineering of cotton mills, we may do so again, and enquire the reasons for the continuous success of the Lancashire boiler.

The arguments against it are :—

It is costly ; it is large and clumsy ; it requires a heavy outlay in brickwork for seatings.

On the other side we may say :—

Though costly it is durable.

Though large, it is not specially so for its output of steam.

Though costly to set, it gives economical results.

Further, as stated, it may be made smokeless.

The special points which have made it a favourite with the cotton spinners, who want steady turning, are its large steam space and its large water contents. When at work, and heated throughout, it has an enormous store of heat. A sudden demand for more steam is readily responded to, for a small fall in pressure sets free a large amount of heat from the mass of water, and conversely on a stoppage of demand for steam the water will absorb the heat of the furnaces, and pressure will only slightly increase.

The boiler is, in fact, an accumulator or heat reservoir, and it is practically universal as the steam producer for motive power in the textile districts of Lancashire, Yorkshire, Cheshire and Derbyshire.

The demands of the textile factories closely resemble those of an electric installation, and it would appear reasonable to conclude that for first class installations of an extensive character involving several hundred indicated horse-power, steam boilers of the above type will give the best results in working and in fuel economy, allowing, as they do, of the use of any description of fuel which may be cheapest.

Feed water heaters ought to be worked in conjunction, though the heat rejected by the Lancashire boiler is not so great as that rejected by other boilers which have no external brickwork flues. The feed heater of the vertical water pipe variety has so far been the favourite to accompany Lancashire boilers.

For usual conditions, probably the best dimensions will be :—Boilers of 7½ or 8 feet internal diameter and of a length about four diameters.

The advantage of the larger boiler is the better combustion in its larger furnaces.

The furnaces of a 7 feet 6 inches boiler will be 36 inches diameter ; those of an 8 feet boiler 39 inches or 40 inches diameter. When hand fired, a firegrate length of 6 feet is usually as much as an ordinary fireman can keep properly covered and attended to.

This gives a grate area of 36 square feet in a 7½ feet boiler, or 40 feet for the 8 feet size.

The consumption of coal will range from 15 to 25 lbs. per square foot per hour.

About 21 lbs. is a good, comfortable rate, for constant work, which implies 840 lbs. of coal per hour in the 8 feet boiler, and an indicated horse-power varying, of course, with the class of engine. Taking the usual style of compound engine employed in the North, a horse-power requires about 1¾ lbs. of coal per hour, and on this basis an 8 feet boiler will serve for 480 I.H.P. with fair coal and condensing engines.

The example set at the Deptford station of placing their motive power near an unlimited supply of condensing water will surely find imitators, and there can be little doubt that steam power on a large scale will be found too expensive to produce within City limits. The placing of boilers in cellars and the attendance of machinery in dens of discomfort cannot be fraught with economy or long carried on satisfactorily.

In preferring what some style the old-fashioned Lancashire boiler to the newer productions of the water-tube boiler makers, we may be charged with mechanical Conservatism, and yet we do so fully confident that the boiler which will best survive is the so-called older type. Water-tube boilers, we are told, are extensively used in the United States. As we have already stated, the conditions there are different, the coal suited to such boilers is found there abundantly, and used almost to exclusion in New York and some other cities.

At the same time, the boiler which is *par excellence* the American boiler is not the water-tube boiler, but the under-fired cylindrical boiler with return tubes of 3 or 4 inches diameter. These boilers, the usual length of which is, perhaps, 12 feet, and the diameter 5 feet to 6 feet, are turned out by American boiler works at a remarkably rapid rate. For efficiency and small first cost they are, perhaps, the cheapest boiler made, and for bituminous coals their wide under-furnace with brick sides gives them a good

chance when properly set of being worked without smoke. English boiler insurance companies do not like boilers of this type; they object to under-firing of a shell exposed to pressure, and yet one is tempted strongly to question the legitimacy of this objection in face of the fact that such boilers are worked in America at pressures which are for single-riveted boilers higher than those allowed for double-riveted boilers in England, whilst for a certain section of the country and certain boilers, the working pressures exceed English test-pressures.

A fact which goes a long way to place American boiler-making, in spite of much crudeness, on a good basis, is the law which fixes the working pressure from the ultimate tenacity of the plates and their ductility.

These American under-fired boilers, it should be noted are very short.

This fact must surely—or ought surely to—tell in their favour as compared with the customary length of English under-fired boilers.

Granted that under-firing distresses a boiler, the distress must be least in a short boiler, the under seams of which are not so liable to be strained by the movement of a long unsupported length. This may easily happen with a 30 feet long boiler, should the setting give way even an eighth or a quarter of an inch over a portion only of its length.

These short under-fired boilers are, at least, always of fairly uniform temperature throughout, and on the score of cost, efficiency and cheapness, are on a better footing than water tube boilers, whilst, as regards steam space, water volume, and steadiness of working, it is doubtful if they are any way behind the Lancashire boiler, and we do not see why this simple American boiler could not be largely used with safety, especially at English pressures, or why the external firing of a boiler need take the hair off any chief engineer of a boiler insurance company, especially if the water is pure, or of such nature as to be amenable to some of the many forms of mechanical sediment removers known to be good and serviceable. While, therefore, the Lancashire boiler appears to stand pre-eminent as the steam producer for very large installations of electric machinery, the simple under-fired return tube boiler, set in brickwork, follows very closely for smaller permanent work. When employed, it should have a combustion chamber of considerable size at the back end for the gases to become thoroughly burned previous to traversing the return tubes, and also a clear and distinct vertical water space up the middle of the tubes, which should thus be arranged in two wings, so to speak. This will facilitate circulation, and promote steam dryness, which is so important a factor in economy.

THE SCOTT-SISLING ACCUMULATOR CHARGING SYSTEM.

PRIVATE installations generally involve the use of accumulators and to charge these the dynamo voltage must of course be raised some 25 per cent. above the lamp voltage.

In many cases this is inconvenient and wasteful, as the dynamo must be "run up" to this increased voltage, although only a small portion of the current generated can be used for charging, the remainder being required for the lamps at the normal voltage.

We illustrate a neat arrangement devised by Messrs. W. B. Sisling and W. H. Scott which seems to overcome this difficulty, and has several features which ought to prove advantageous in a private installation.

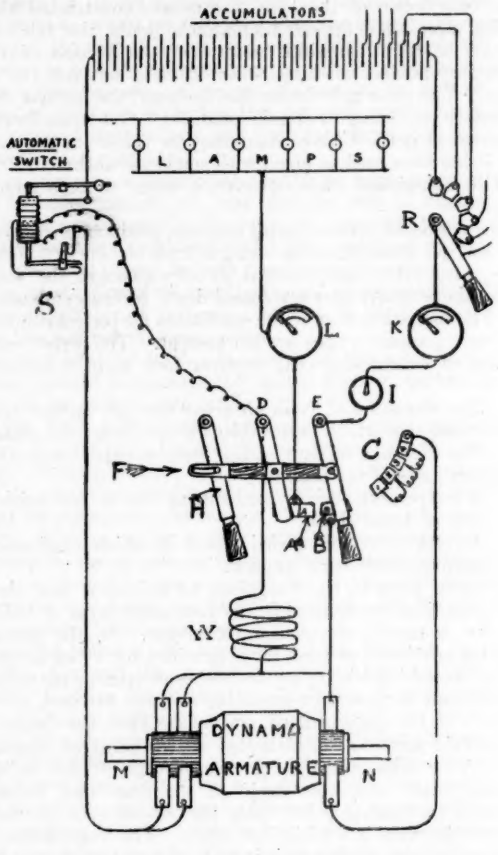
The arrangement may be described as a compound dynamo with a small supplementary winding on its armature connected to an extra commutator which gives a voltage usually about one quarter of that given by the main commutator.

A branch is taken from the main circuit and connected so that the extra commutator raises its voltage by about 25 per cent. This forms the charging circuit.

The dynamo can thus be driven at constant speed, and will supply constant voltage to the lamps from its main circuit undisturbed by the increasing voltage from the cells during charging.

The whole of the cells can be charged and a large current supplied to the lamps at the same time, as this does not pass through the regulating cells.

The charging can therefore be accomplished during the hours of lighting instead of the dynamo having to be run specially during the day.



DESCRIPTION OF ARRANGEMENT.

The diagram shows the general arrangement. The dynamo armature has a main commutator, M, and an extra commutator, N. These two commutators are connected in series, either directly or through the dynamo series winding, W. The switchboard contains two switches, viz., the dynamo switch, D, which connects the dynamo to the lamps and the accumulator switch, E, which connects the accumulators in either of three different ways, viz.:—

A to the lamps alone, or

B to the lamps and dynamo, or

C to the charging circuit.

These two switches are of the lever pattern, and are interlocked by the thrust rod, F.

The handle, H, acts on the thrust rod so that it can only put the dynamo switch "on." To take it "off" the accumulator switch must be moved so that the accumulators are connected to the lamps alone.

When the dynamo switch is put "on" the thrust rod moves the accumulator switch from A to B, thus connecting the accumulators to the dynamo in such a way that they are in readiness to assist the dynamo in supplying current to the lamps, without risk of weakening or reversing its magnetism.

If the dynamo does not need assistance, and spare power is available, the accumulator switch may be moved further from B to C, when the dynamo will begin to charge the cells by means of its extra commutator, N, without interfering with the constant voltage which is supplied to the lamps from its main commutator, M.

An index, I, shows whether the accumulators are being charged or discharged, whilst an ammeter, K, indicates the *amount* of the charging or discharging current.

A second ammeter, L, shows the current taken by the lamps.

A pilot lamp on the switchboard lights when the dynamo starts up.

By means of this arrangement the manipulation is made simple and the charging current can be adjusted to form a complementary load, thus working the plant at its maximum efficiency and shortening the hours of running.

The arrangement is in use in some private installations, the latest being one erected for Baron V. de Barreto, of Brandon Park, Suffolk, which is driven by an oil engine giving 11 B.H.P. The engine is started by the accumulators, and these also work the coil which ignites each charge in the engine cylinder.

The whole arrangement seems to work satisfactorily and without specially skilled attention, which is an important matter for country houses.

The special dynamos and switchboards are manufactured by Messrs. Laurence, Scott & Co., Norwich.

PRACTICAL PHOTOMETRIC RESEARCH.

By RALPH CONRAD RICHARDS.

(*Continued from page* 299.)

PART III.

AT the close of the last article, reference was made to the deterioration of the incandescent lamp, and the action of disintegration was dealt with briefly. It is now proposed to enter more fully into the relation of the various other physical forces to the incandescent filament. Disintegration itself may be defined (should an explanation be needed of what is really a self explanatory word) as a casting off of particles from a solid body, due to the action of a physical agent—generally heat; it may be said to be due to their gradual loosening by expansion. In the case of homogeneous bodies such as steel, where the cohesive attraction is great, this does not occur until a temperature very nearly approximating their melting point has been reached; with bodies whose cohesive attraction is less, disintegration will be found invariably to occur to a greater extent. Physicists do not seem to have recognised the great difference existing between what may be termed mechanical cohesion, and the more generally known physical cohesion; to make matters more clear the latter may be defined as the ease with which the particles of a body may be separated physically, as distinct from the well-known mechanical separation; thus the general science of physics deals with the former and not with the latter, it being usual to state that that body possesses the greatest attractive cohesion, whose particles are susceptible of physical alteration of state with the greatest difficulty by a physical agent, such as heat. Now in the incandescent carbon filament, one has the case of a body having great physical, but relatively small mechanical cohesive attraction; a comparatively gentle blow will reduce a filament to a powder, whilst it requires a considerable application of heat to cause the same destruction; energy amounting to a foot pound will readily dissipate a filament when applied to it mechanically, whereas the same energy acting upon the same filament, in the form of heat, will not affect it perceptibly; supposing, of course that the energy is expended upon it as work at the same rate in each case. The writer considers that the disintegration of the filament is, in the first case, facilitated by the very loose structure of its substance. If carbon could by any means be so heated as to assume the liquid form, it is probable that the incandescent lamp might be constructed so as to give an efficiency almost equal to the arc; while its life would for the same reason, be extended to a period, which in view of the present state of affairs might be considered infinite. Modern science has made it possible to obtain an almost perfect vacuum, so that in so far as combustibility is concerned the life of a lamp is already assured, for it must be remembered that an exhaustion equal to one-tenth of a millimetre of mercury is equal to about one-fourth that amount of oxygen; and this is readily converted into a harmless gas by the oxidation of the exterior skin of the carbon at the first incandescence. It has not yet been considered whether it would be cheaper in the end to be satisfied with a lower efficiency, thereby avoiding the disintegration which must generally occur, with a higher one. It is generally known that a lamp shows (on measurement) a very considerable drop in efficiency, after a few hours from the commencement of its *life*; in some cases this has amounted to 80 per cent., and although this is somewhat exceptional, it, nevertheless, goes far to show the fallacy of instituting comparisons from the initial runs, as is generally done. It is true that a new lamp may give an efficiency of 3 or even 2½ watts per candle, but a very few hours will make a considerable difference. Now all who have attentively observed lamps under various voltages will see the enormous gain after passing a certain limit. The effect of a ten cell battery is annexed below.

TABLE IV.*

No. of cells in series.	Effect produced.		
1	Nil		... ...
2	„		... ...
3	Faint red heat		C.P. inappreciable.
4	Cherry red		„ small.
5	Orange		... ...
6	Yellow	approximately.	About ¾
7	Whitish yellow ...		„ 1
8	Whiter „ ...		„ 1½
9	Very white		„ 2
10	Intense bluish yellow		„ 2¾

* The battery consisted of 10 quart Daniell's cells, Zn SO_4, in the porous pot.

The candle-power of the lamp employed in the experiment referred to in above table, rose gently from the instant when third cell was connected in series, until the seventh had been included; from this point the gain per cell was enormous, the greatest advantage being gained on the addition of the last cell; although on first sight it may appear that for this reason it would be prudent to increase the voltage to any extent (providing of course that the life of the lamp be not unduly endangered), yet unfortunately it is just this increase which causes the disintegration and resulting inefficiency; for, although by working with a great voltage, the efficiency is increased greatly, yet, as remarked above, it is from this point that the disintegration always commences, and, after the lapse of a period which when compared with the total life of the lamp is very short, the efficiency sinks down to that which might be obtained with 90 per cent. of the energy expended on a new lamp; thus far the loss has been comparatively insignificant; unfortunately, however, in the future the lamp in question will require energy = 100, to yield light = 90, or probably far less. Whereas, if the lamp had in the first instance been worked at a lower voltage, although the C.P. thereby obtained would have been lower, yet the energy employed would have been less, so that a lamp suited to a higher voltage could have been substituted and run at the same voltage as the former lamp, the same efficiency (comparatively speaking), being obtained throughout its life. It may be urged by some that the writer is devoting too much space to this very apparent question; to such he would reply, that it requires no great expenditure of energy to produce lamps so blackened that but 50 per cent. of the light given off from their filaments is transmitted through them; as a remedy he would suggest larger globes, for experiment, and common experience shows that the blackness and opacity due to a given degree of disintegration is proportional to the area of the globe. As an alternative he has considered that lamps might possibly be constructed having a small piece of apparatus, as illustrated in fig. 3, inside them;* this consists of a small soft iron ball about ¼-inch in diameter and perforated equidistantly in many places; into the seperforations are inserted bunches of bristles, thus forming a species of *ball* brush. If now a powerful electro-magnet be held against the side of the globe, this iron brush will be attracted, and, by moving the globe about as in fig. 4, the entire interior surface may be speedily denuded of its deleterious covering. The advantages claimed over the first method (that of increasing the size of the globe) are as follows:—In the first place because this method allows the lamp to be worked at the highest efficiency consistent with

* The writer has not yet put this idea into practice.

durability of life; and secondly, the arrangement possesses very great simplicity and economy; for it is considered that the cost of the little ball, which should not in any case exceed that of the first method, would be readily covered by the great gain in efficiency. In addition to the disintegration which has been dilated upon here, there is evidently another reason to account for the deterioration of the incandescent lamp, the writer refers to the peculiar case cited in the foot-note, page 299. It becomes at once obvious that the disintegration theory will not cover this, for if such occurred at all, the detached particles of carbon would be precipitated

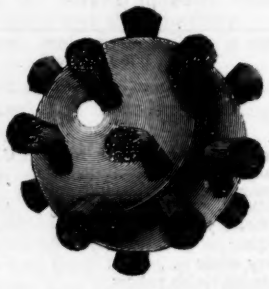


FIG. 3.

on to the glass, or at least if cast off at all, they would fall as a powder to the bottom of the lamp globe; since, however, they do not do this, some other modification must occur which causes deterioration in the lamp, and this is evidently an increase of surface. Everyone who has had any experience at all with incandescent lamps (or even of any form of carbon conductor subjected to a high temperature) knows that the resistance of an old lamp is greater than of a new one; for as the particles become loosened with the continual wear and tear which the high temperature to which they are subjected entails, it follows that the distance between each individual particle becomes greater; and this it may be proved (should it be necessary to do so), upon abundant testimony, can but result in an elevation of resistance, both specifically and otherwise. The microphone affords a very excellent example of this fact, and the reader will readily

FIG. 4.

see the connection between the two—in both cases carbon is the substance in question. A decrease of pressure causes an increase of resistance in each case, and although this decrease of resistance is in the one case dependent upon the mechanical action of sound waves, and in the other on account of excessive elevation of temperature, it will, nevertheless, be seen that a very perfect parallelism obtains. Now, if as may readily be demonstrated, the particles of the filament may be so readily cast off, is it not reasonable to suppose that some inherent peculiarity in the lamp may produce by similar means, opposite results, *i.e.*, an increase of surface; for if the particles be not cast off, it is apparent that as loosening has occurred, the total radiative surface has been lessened; and further, as these outer particles are not necessarily in the direct path of the current (being partially detached from the main body of the filament) they would act in the double capacity of absorbers and low radiators (if the two attributes can be attached to one substance). Thus these outer layers being necessarily less heated than the inner, will absorb heat from the interior particles, but as the contact may be assumed to be very imperfect and the increase of radiative surface very great, the resultive temperature will be less, and consequently the resulting efficiency far lower; this is, in the author's opinion, a very plausible explanation of a state of affairs, which, by the disintegration theory receives absolutely no elucidation.

The reason for dwelling on this matter at length is this: as the manufacture of filaments is improved, the compactness becomes less, and hence also the disintegration; so that the probability is, that in the future it may be expected that an over-run lamp will become inefficient on account of reasons already laid down in the latter part of this article, and not, as at present, by disintegration.

The period which must elapse before these words become fulfilled may indeed be a long one; but it would be unscientific and absurd to say that a durable filament will never be invented. The whole question rests on the probability of obtaining a powerful heat source—as yet it is only possible to reduce carbon to a pasty condition—liquid carbon is a future consideration; to attain to this it will be necessary to obtain a heat source far in excess of the electric arc; the possibility of doing this seems somewhat remote, but it must be remembered that the oxyhydrogen flame was once thought by physicists to be unsurpassable. The writer recently read of some experiments using a large condensing lense, and these seem to him to cover many probable advances; it is, however, out of place to discuss this question in an article upon photometry, inasmuch as the question is far more connected with lamp manufacture.

(To be continued.)

ELECTRICAL CONDUCTIVITY AND THE FREEZING POINT.

IN our issue for March 27th of this year, in an article entitled "An attack upon the dissociation theory of Arrhenius," we reviewed a number of objections raised by J. Traube to the hypothesis formulated by S. Arrhenius of the dissociation of electrolytes in dilute aqueous solutions. Traube's attack was given in full in the *Berichte der deutschen chemischen Gesellschaft*, xxiii., pp. 3,519—3,530.

The reasoning endeavoured to demonstrate that the simple relation which is stated by Arrhenius to exist between the electrical conductivity and the freezing point is not based upon experimental results and therefore has no foundation. Moreover, Traube asserted that the dissociation hypothesis contradicts our ordinary conceptions of chemical affinity.

In No. xxiv. of the *Berichte*, there is a further paper by Traube, in which he supports his contention that the alleged relation between the freezing point and electrical conductivity has no experimental foundation.

In support of this contention, it is shown that the non-electrolytes, such for instance as phenol, urea, cane-sugar, &c., have a definite molecular conductivity which increases according as the solutions in which they may be dissolved are diluted, and hence the value of $i = 1$, which is assumed by Arrhenius in his reasoning, must of necessity be wrong.

Traube also shows in his last paper upon the subject, that in the case of electrolytes, the values that are obtained for i, vary enormously according as the solution in which these electrolytes are dissolved are concentrated. Further, he points out that in no instances in which the values, calculated from the conductivity and those calculated from the freezing point of solutions of electrolytes of the same concentration were compared, was any agreement between the two acts of number observed.

This is another hard nut for the promotor of the dissociation theory to crack. He has successfully disposed of some of his antagonists, but in Traube he finds a most persistent and able critic full of resources and subtle reasoning.

ON THE PROGRESS OF TELEGRAPHY AND TELEPHONY IN ENGLAND.*

By WILLIAM HENRY PREECE, F.R.S., &c., Electrician to the British Post Office.

I FEEL very highly honoured at being invited to deliver an address before this distinguished assembly. As I have entered my 40th year of continuous service in the development of electrical industries, I take as my subject that branch with which I have been most intimately connected. In 1852 the telegraph instrument in use in England was Cooke and Wheatstone's double needle. One wire (half the circuit) transmitted on the average 10 words a minute. Now, in 1891, one wire transmits 600 words a minute. Then one wire sent only half a message. Now one wire habitually transmits six different messages at one and the same time. Then messages cost one shilling a word; *now* they cost *one halfpenny*.

This great advance is due to the eminently commercial character of the telegraph, and to the absence of any insular prejudice or national jealousy in the telegraphic world. A good invention, by whomsoever it may be invented, is not only certain to receive consideration in England, but if it expedites or cheapens transmission, it is sure to be adopted and rewarded. We have thus in actual use all the most important telegraph inventions of the age.

The early telegraphs were established and developed by private enterprise; but when the facts became recognised that the telegraph supplied a public want, that it was essential to the public weal, and that competition favoured the speculative few to the loss of the patient many, the public stepped forward and told its slave, the British Government, that the telegraph it wanted, and the telegraph it would have. Since 1870 it has been in the hands of the British Post Office, and its growth during this period is shown by the following table:

There are four things essential to the commercial success of telegraphy:—

1. Well constructed lines that shall be free from interruptions.
2. Perfect working apparatus that will develop each circuit to its utmost capacity.
3. A well-educated staff, not afraid of work, and trained to habits of accuracy.
4. Rapidity of delivery of messages.

1. In England we use poles of stout creosoted timber well-stayed and strutted, fixed about 60 metres apart, so as to secure strength and rigidity of structure in our stormy and wet climate. I attribute freedom from contact between the wires themselves more to this absence of vibration in our supports than to any other cause. Copper is very much used, and it is being rapidly introduced for all long and important circuits, and our insulators are as perfect as they can be made with our present materials. In all cities and large towns the wires are covered with gutta-percha, and are drawn into iron pipes buried underground.

2. The favourite instrument is the sounder. Messages are read by the ear and not by the eye. It is by far the most accurate instrument in use. The Morse recorder is to us a fossil, rejected for its antiquity and liability to error. The sounder secures accuracy by securing proper "keying," that is, by enforcing proper hand manipulation. It is also simplicity itself in its design and structure, and rarely fails to work. To us it is amusing to find the argument still used that there is security in retaining a record so as to check error, and detect the maker of the error. Facts are stubborn things, and their logic is irrefragable.

The sounder lends itself to duplex, quadruplex, and multiplex working, without any change of system.

The beautiful Hughes type-printer is used in England only for the continental traffic. It does not possess the elasticity and simplicity of the sounder, nor its adaptability for multiplex working.

Table showing the Total Number of Telegrams forwarded from Telegraph Offices in England and Wales, Scotland, and Ireland, in each Year since the Transfer of the Telegraphs to the State.

Year.	Number of Telegrams.					
	England and Wales.			Scotland.	Ireland.	Total.
	Provinces.	London.	Total.			
1870-71	5,299,882	2,863,821	8,163,709	1,080,189	606,285	9,850,177
1871-72	6,594,590	3,612,772	10,207,362	1,388,434	878,000	12,473,796
1872-73	8,022,151	4,577,015	12,599,166	1,761,298	1,175,316	15,535,780
1873-74	9,233,854	5,254,547	14,488,401	2,009,893	1,323,236	17,821,530
1874-75	10,124,661	5,652,033	15,776,694	2,132,787	1,343,639	19,253,120
1875-76	10,883,282	6,350,714	17,233,996	2,287,359	1,452,180	20,973,535
1876-77	11,232,704	6,561,930	17,794,634	2,402,347	1,529,162	21,726,143
1877-78	11,392,098	6,700,504	18,092,602	2,490,776	1,588,489	22,171,867
1878-79	11,592,899	8,830,019	20,422,918	2,477,003	1,559,854	24,459,775
1879-80	12,392,996	9,854,566	22,247,562	2,704,574	1,595,001	26,547,137
1880-81	13,456,555	11,176,459	24,633,014	3,042,291	1,736,677	29,411,982
1881-82	14,204,479	12,071,034	26,275,513	3,207,994	1,862,354	31,345,861
1882-83	14,554,015	12,374,707	26,928,722	3,244,202	1,919,102	32,092,026
1883-84	14,920,413	12,686,433	27,606,846	3,299,428	1,936,846	32,843,120
1884-85	15,195,618	12,930,376	28,125,994	3,257,546	1,894,919	33,278,459
	SIXPENNY TARIFF.					
1885-86	18,029,008	15,081,433	33,110,441	3,812,173	2,223,669	39,146,283
1886-87	24,044,077	18,276,108	42,320,185	5,106,774	2,816,680	50,243,639
1887-88	26,052,717	18,872,554	44,925,271	5,430,623	3,047,531	53,403,425
1888-89	28,269,130	20,263,539	48,532,669	5,991,223	3,241,455	57,765,347
1889-90	30,873,953	21,562,826	52,436,779	6,545,654	3,420,966	62,403,399
1890-91						

The figures for each year since 1877-78 include the number of certain Press telegrams not previously included in these returns.

Prior to 1883-84 the returns were made to the end of the last complete week in the year. Since that time they are in each case to the last day of the year, inclusive. On October 1st, 1885, the minimum charge for an inland telegram was reduced from 1s. to 6d.

Return Showing the Amount of Business Transacted on Multiplex, Quadruplex, and Wheatstone Automatic Circuits at T. S.

Offices.	Date.	Time covered by return.	No. of hours	Total messages.		Combined total.	Average per hour.		Combined average per hour.	Highest total per hour.		Highest combined total per hour.	Remarks
				Forwarded.	Received.		Forwarded.	Received.		Forwarded.	Received.		
WHEATSTONE AUTOMATIC DUPLEX.													
London and Jersey	June 9, '91	8 a.m. to 8 p.m.	12	773	1,116	1,889	64·4	93·0	157·4	101	311	412	During potato season.
" " Lincoln ..	Mar. 26, '90	8 a.m. to 8 p.m.	12	380	1,155	1,535	31·6	96·2	127·8	53	276	329	" race meeting.
" " Henley	July 10, '90	8 a.m. to 8 p.m.	12	756	840	1,596	63·0	70·0	133·0	139	137	276	" regatta.
" " Doncaster ..	Sept. 9, '90	8 a.m. to 8 p.m.	12	479	1,210	1,689	39·9	101·6	141·5	91	228	319	" race meeting.
MULTIPLEX.			No. of arms.										
London and Bristol ..	Aug. 11, '91	11 a.m. to 1 p.m.	2	127	94	221	63·5	47·0	110·5	95	67	162*	
" " Birmingham	Aug. 10, '91	10 a.m. to 2 p.m.	4	316	129	445	79·0	31·7	110·7	90	32	122*	
" " Hull ..	Aug. 10, '91	10 a.m. to 2 p.m.	4	259	255	514	64·7	63·7	128·4	67	70	137*	
" " Liverpool	June 23, '91	12 noon to 3 p.m.	3	248	..	248	82·6	..	82·6	103	..	103*	Forwarding wire.
" " "	Aug. 12, '91	12 noon to 3 p.m.	3	..	226	226	..	75·3	75·3	..	96	96*	Receiving wire.
QUADRUPLEX.													
London and Bristol	July 21, '91	9 a.m. to 8 p.m.	11	505	489	994	45·9	44·4	90·3	79	54	133	Only worked full quadruplex during these hours.
" " " ..	July 9, '91	9 a.m. to 2 p.m.	5	206	134	340	51·5	33·5	85·0	56	35	91	
" " Liverpool ..	July 1, '91	10 a.m. to 5 p.m.	7	249	346	595	35·5	49·4	84·9	58	80	138	

* Only worked to full capacity (all arms) during the hours stated.

* Read at the International Electrical Congress, Frankfurt-on-the-Main, September, 1891.

A record of the rate of work done by the different classes of circuits used in England will not be uninteresting. (*See Table.*)

The high speed which has been attained in automatic telegraphy is due:—

1. To exquisite manufacture of apparatus.
2. To the entire elimination of all retarding effects in the apparatus.
3. To the introduction of relay stations.

The second improvement is due to the introduction of the shunted condenser, one of the most important principles, and one which is more and more recognised every day. It was originally introduced by von Helmholtz to remove sparks in coils, and by Cromwell Varley to facilitate telegraph working on long cables, but it remained for the British Post Office to show how it could be used to eliminate electromagnetic inertia. Maxwell had shown in his great work how capacity and self-induction were of a similar nature but of opposite effects, but he never suggested, as has been stated, how they could be made pratically to neutralise each other.

I regard the introduction of the shunted condenser into telegraphy as an important a step in advance as the introduction of compounding into steam engines.

We use in England a system of working by double currents which is most beneficial. Currents are always on the line, and we simply reverse their direction to make the Morse characters. We have been able to abandon the use of antagonistic springs in our relays, and thus their sensitiveness is greatly increased, and we employ in consequence less battery power. It improves also speed of working, especially in long underground lines.

3 and 4.—Successful telegraphic business is dependent on accuracy and despatch. The engineer may keep his wires in admirable order, the electrician may perfect his apparatus, the telegraphist may transmit and write down with absolute accuracy, but all the effect of this may be lost if the message is not promptly delivered. A loitering messenger is the bane of the telegraph. In England we employ boys alone for this work, and we pay them practically by results. The boy who delivers the greatest number of messages earns the highest pay.

A message can now be sent between any two places in England and a reply received within half an hour, if the recipient of the message resides near a post office. If this time is exceeded, it is almost invariably a delay in delivery, either because the receiver resides far away or because he is not to be found.

The influence of this promptness in despatch and delivery is shown in the growth of the local telegraph business in London:—

Years.	Total number of telegrams per annum.	
1870	242,007	*No record kept for January and February, 1870
1871	465,878	
1872	552,960	
1873	683,742	
1874	762,065	
1875	883,516	
1876	1,031,865	
1877	1,095,277	
1878	1,244,560	
1879	1,319,406	
1880	1,464,843	
1881	1,623,711	
1882	1,708,002	
1883	1,754,764	
1884	1,804,017	
1885	2,171,516	October: 6d. tariff introduced
1886	3,635,432	
1887	4,237,020	
1888	4,695,057	
1889	5,182,414	
1890	5,714,675	

* Actual date of transfer, February 5th, 1870.

A comparison between the years ended March 31st, 1884-5, and 1890-91, will perhaps afford the best evidence as to the growth of telegraph business; the former being the last complete financial year in which the 1s. rate was in force, the 6d. rate for inland telegrams having commenced in October, 1885.

	1884-5.	1890-91.	Increase per cent. in 1890-91.
Number of telegraph offices open for the transaction of public telegraph business ...	6,027	7,627	26
Mileage of wire (public and private) in use	155,568	194,312	25
Total number of telegrams (inland, foreign and press) ...	34,256,503	68,622,117	100
Total receipts of all kinds ...	£1,755,119	£2,416,690	38

During the first year of the sixpenny tariff, the value of an inland telegram averaged 8·12d.; but it has gradually declined, and it is now somewhat under 8d.—that is, the number of words in each message is just under 16.

The Great Central Telegraph Office affords a striking example of the increased amount of business developed by reduction in tariff and promptness in despatch; 50 per cent. of the work in the United Kingdom is transmitted through this office.

	1884-5.	1890-91.	Increase per cent. in 1890-91.
Staff	2,220	3,453	55
Annual amount expended in salaries and wages...	£184,171	£322,960	75
Total number of telegrams passing through the office	15,877,084	32,537,779	105

The work done for the Press is enormous in England.

5,003,409 Press telegrams, containing 600,409,000 words, were delivered to the public in the year ended March 31st last, about 2,000,000 words per day.

This gives an increase in the last 10 years of 83 per cent., the numbers for the year ended March 31st, 1881, having been respectively 2,735,042 telegrams and 327,707,407 words. The price paid is a little over 2d. per 100 words. Pneumatic tubes form a distinct feature of telegraphy in London and other large cities.

The British Pneumatic Telegraph System had its inception in 1854 in a single tube, 220 yards long, laid by Mr. Latimer Clark (whose assistant I then was) for the Electric Telegraph Company, in London. It comprises at the present time, besides numbers of short local tubes worked by hand-pumps, 141 tubes worked by steam or gas engines; of these, 84 are in London, 17 in Manchester, 14 in Liverpool, 12 in Birmingham, 6 in Glasgow, 5 in Dublin, 2 in Newcastle-on-Tyne, and 1 in Bradford. The aggregate length is 48 M. 349 yards, and the power developed by the 21 engines employed, is, under ordinary working conditions, upwards of 520 I.H.P. About 120,000 messages are carried daily, the average time of transit of a carrier through a tube half a mile long being a little over a minute.

The tubes which are usually 2¼ inches in internal diameter, are of lead, enclosed in cast iron pipes for protection, and laid beneath the footways. They radiate from the central station to the branch offices, and are always operated from the central station, the outgoing carriers being propelled by "pressure" and the incoming ones being drawn by "vacuum." In a few cases carriers are despatched and received on the same tube; but, as a rule, separate tubes are provided for "up" and "down" traffic. The passage of carriers is regulated by electric signals worked upon a "block" system like a railway, the longer tubes being divided into sections with automatic intermediate signallers.

Telephony.—I am not able to give such statistics of progress in the use of the telephone. We are quite ashamed of the telephone in England. It is still in that stage when it is supposed to be best administered by private enterprise. Our masters, the public, have not yet told us to take it in hand; when they do we shall probably be able to tell as good a story of progress as I have told you of telegraphs. But we have developed it technically. We have shown the practicability of long distance telephony, by establishing a very successful circuit between London and Paris, 311·3 English miles, or 498 kilometres long.

There is no circuit in or out of London on which speech is more perfect. We have spoken also between London and Brussels, Lyons, and Marseilles, the latter circuit being 1,440 kilometres long.

The charge for a conversation between London and Paris is 10 francs (or 8 marks) for 3 minutes' complete use of the wire. The average number of talks per day is 86. The maximum in one day has been 118. We have had as many calls as 19 per hour. 450 words have been sent and recorded in 3 minutes, which means *five words for a penny.*

We have gradually removed one by one all the difficulties due to internal and external causes that rendered long-distance speaking impossible. We have reduced telephone circuits to silence, in spite of 10,000 volts and alternating currents. Heavy copper conductors, low inductive capacity, metallic circuits, and twisted wires, have eliminated all inductive troubles.

The law determining the distance to which speech is possible is given by my formula:

$$K R = t,$$

t being the time constant of the circuit expressed in millionths of a second, R being the resistance in ohms, and K the capacity in microfarads. R is very easily measured, but K is much more difficult to be determined, and is subject to variation due to mutual induction. Fortunately, this variation being negative, is helpful in its character, that is, it reduces the value of K, and it therefore increases the distance to which speech is possible. The K R of the London-Paris circuit was calculated to be = 7,359, it is really about 5,000. It is owing to this reduction of K that the line speaks better than we calculated, and this is also why we were able to speak to Marseilles.*

In a commercial country like England, an invention to attract attention and to prosper must be patented. It must have the

* My K R scale is this:—

15,000, speech impossible.
10,000 „ possible.
7,500 „ good.
5,000 „ excellent.
2,500 and under speech perfect.

prospect of great gains to attract capital. It must therefore be developed by private enterprise. When a new industry has thus been developed, and when it affects the public weal, Government is forced to step in and take the control of it. It has absorbed the telegraph, it controls the railways, and it regulates the supply and use of electrical energy for light and for power.

Your President has very pithily remarked:—"Intercommunication is the sign under which the world stands at the close of the present century. The barriers separating nations are thereby overthrown, and new relations established between them." And I cannot conclude with any sentiment more *apropos* to the story I have tried to tell you.

LEGAL.

"Faure" Patent in Germany.—The following extract is taken from the Berlin *Borsen Courier* of September 11th:—A case which for some time past has aroused much interest in the electrical world came up for decision last Thursday before the Nullity Department of the Imperial Patent Office. The Joint-Stock Accumulator Company, of Hagen, in Westphalia, is the holder of a license in respect of the patent granted in 1881 to Camille Faure for the production of accumulators. The extraordinary success attained by this industry, both in this country and abroad, led last year to the conversion of the original company into a large joint-stock undertaking, in which, among others, the Allegemeine Elektricitäts Gessellschaft, and the firm of Siemens and Halske became interested to a very considerable extent. On the other hand this very success led, especially in Germany, to attempts at evasion of the rights patented by Faure, and the Accumulator Company found themselves obliged to defend actions both in the civil and criminal courts against the firms of the Berlin Accumulator Company, Correns & Co., de Khotinsky, Gelnhausen and Gottfried Hagen, of Cologne on Rhine. These firms in turn combined together with a view to obtaining the right to employ Faure's patent without charge, and instituted a suit for the nullification of the rights secured by Faure's patent. This suit came on for decision before the Imperial Patent Office last Thursday. All motions made by the petitioners for annulment, in order to obtain a postponement of the case, the institution of experiments, hearing of witnesses both in this country and abroad, were disallowed by the Imperial Patent Office, it being decided that sufficient material was already before the court on which to give a decision. The assertion advanced by counsel for the petitioner, Dr. Haberlain, patent attorney of Berlin, namely, that accumulators similar to those patented by Faure were already perfectly familiar to experts in consequence of the published writing of Planté, Kirchhoff, de la Rive and Brush, and from a combination of the publications of the published writings of Prof. Stockhardt and Dr. List, and the experiments of Dr. Aron, of Berlin, previous to the announcement of Faure's patent, was shown by the counsel for the defendants, engineer and patent attorney Pieper, of Berlin, to be in each separate instance inaccurate. In like manner, the alternative plea advanced by the plaintiffs, to the effect that the only point which could be held to be protected by the patent was a layer supplied by means of a brush in connection with partition walls, was shown to be quite unsupported; it was, on the contrary, proved that neither the specification nor the claims of the patent contained anything which was not capable of practical realisation, proof being advanced in support of this view to the effect that over 20 millions worth of accumulators constructed on Faure's system are at this moment employed for purposes of lighting and transport, and attention being drawn to the fact that the only motive which could be suggested for the desire of the petitioners to annul the patent must be to their wish to share in the advantages secured by it. Indeed, the circumstance that they follow Faure's abovementioned specification by applying the layer for the collection of electricity on the electrodes, proves conclusively that Faure had given clear and precise instructions for the production of accumulators. The fact that the form of the conductor employed for the reception of the active layer used to store the electricity was a new one did not in any way justify the petitioners in the previous application of such a layer of active material to plates other than those first of all employed by Faure in the case of such active layers. The Imperial Patent Office admitted the force of these arguments by granting the demand of defendant's counsel that the appeal lodged by the petitioners should be disallowed, thereby declaring the validity of Faure's 1881 patent to be unconditional.

SOME IMPROVEMENTS RELATING TO ELECTROLYSIS.

An improved process for obtaining metallic zinc electrolytically depends for its novelty upon the employment of zinc sulphite instead of zinc sulphate as the electrolyte. This innovation is introduced because of the difficulty of keeping the bath neutral when using the sulphate. Moreover, the metal obtained is of a much better quality, and less power is required for the decomposition of the sulphite than for breaking down the sulphate; this difference is said to be thirty per cent. in favour of the sulphite.

Another improvement grapples with the difficulty of "trees." To prevent the formation of irregular deposits of metal round the edges of the cathodes in the electrolytic method of treating metals, deposits which result in the so-called "trees" which sometimes bring about short-circuiting, the plates are enclosed in frames of insulating material which prevent any deposit from being thrown down at the edges.

Modifications in the apparatus used for electrolysing sodium chloride have been rather numerous of late. Here is one from Austria:—The apparatus is made like a filter-press, that is with a number of frames of suitable material separated by porous diaphragms. The successive frames are alternately anode and cathode cells, the anode cells having an overflow to a channel on one side and the cathode cells to one on the other. All the cells are supplied by a common channel at the bottom to which the diaphragms do not reach. The electrodes are rods of carbon which are so mounted and connected electrically as to be easily removed individually without stopping the working of the apparatus. This apparatus may be used for the electrolysis of various substances, but when sodium chloride is being electrolysed, sodium hydroxide flows off into one side channel and chlorinated liquor into the other.

We will notice here one other recent improvement in the apparatus employed in electrolysis which is of general application. A large tank is filled with the solution that is to be electrolysed; into this tank inverted cylindrical pans are placed, in such a way that one edge of each is raised so as to tilt it from the horizontal. The upper part of each pan contains a large positive electrode of gas-carbon mounted so as to be easily raised or lowered into it. The mouth is covered with a diaphragm of parchment, immediately below which is the negative electrode of wire gauze. Suppose that sodium chloride is being electrolysed, then the caustic soda is formed in the large tank, and hydrogen readily escapes from the under surface of the diaphragm owing to its inclined position whilst chlorine is collected from the top of the pan. There are some ingenious devices for sealing, making the electrical connections, so that each pan can be attended to independently of the others, attaching the diaphragms, leading the gases away, &c., which we need not here enlarge upon.

THE MANUFACTURE OF CAUSTIC SODA AND CHLORINE BY ELECTROLYSIS.

An improvement which has recently been introduced in the production of chlorine gas and caustic soda electrolytically exhibits the following essential features.

The vessel in which the electrolysis takes place is made either of iron or of carbon; in the latter case it is jacketed with an adherent coating of electrolytically deposited copper. This vessel forms the cathode.

The anode consists of a cylinder made of any suitable metal and coated with a layer of carbon; this cylinder is placed in the centre of the vessel which forms the cathode.

Between the two electrodes there is a porous diaphragm consisting of a number of V-shaped troughs made of porcelain; these are built up inside each other, and the intermediate spaces are packed with asbestos fibre or powdered steatite. This curious diaphragm is a special feature of the apparatus and it is stated that it offers much less resistance than does the usual form of porous earthenware. Another advantage claimed for this arrangement is that it prevents the diffusion of the chlorine evolved in the anode section into the caustic soda formed in the cathode section.

The electrolysing vessels may be arranged together in series or used separately.

The raw material is brine. This is supplied from separate tanks to the anode and cathode of the first vessel when a number are arranged in series, and the brine gravitating along the entire series through the respective sections of the cells, flows ultimately into separate catch vessels from whence it is delivered back into the respective tanks.

This circulation is maintained until the solutions are sufficiently decomposed.

The chlorine escapes from the electrolysing vessel through an outlet pipe, in a porcelain cover, which latter seals the vessel.

There is another combination in which an oblong vesse

is divided, by a number of parallel plates (representing the poles) and diaphragms, into anode and cathode sections, through which the respective liquids circulate; but in this arrangement the cathodes are not coated with a layer of carbon.

NOTES.

Alteration of Address.—We are requested to announce that Mr. D. G. Morrison, *sole* agent for Scotland for Mr. Ronald A. Scott, has removed from 135, Buchanan Street, to 57, Miller Street, Glasgow.

The Electric Light in Dresden.—The authorities of the Saxon State Railways have decided, as an experiment, to illuminate their station at Dresden by means of electricity with the view, if successful, of lighting the whole of their stations by that means.

Electric Light in the Strand.—The new premises in the Strand for Upton's well-known restaurant, which are now approaching completion, are being fitted throughout with the electric light. The work is in the hands of Messrs. Rashleigh Phipps and Dawson, Berners Street, W.

Proposed Electric Lighting of Ennis.—At a meeting of the Ennis Town Commissioners last week, the following resolution was adopted:—"That the lighting of the town of Ennis by electricity be taken into consideration at the next meeting of the Ennis Town Commissioners, and that each member of the board get special notice thereof."

Sheffield and Electric Lighting.—There was considerable discussion at the last meeting of the Sheffield town council, as to whether it should be left to some electric lighting company to apply for a provisional order, or whether the council should make the application themselves. It was finally decided by a majority of five members, that the matter should be left in the hands of some outside company. Some years ago, the council went so far as to apply for an order, but the matter fell through as it was considered that the knowledge of electric lighting had not proceeded far enough to enable them to take the matter up.

Electric Light Inspector.—Acting upon the advice of Prof. Forbes, the Bath Electric Light Committee recommended the council to appoint an inspector whose duties shall be to test periodically, and in special cases, the undertaker's electric lines and works, and the supply of energy given by him, to certify and examine meters, &c. The committee considered that the inspector should be required to test the public lamps at least once a month. The report, which recommended the appointment of Mr. J. W. Gatehouse as inspector, at stated fees, was adopted by the Council.

Brighton Electric Lighting.—At the Brighton council meeting held recently, Councillor Styler asked that as the lighting committee had announced that they would soon be ready to supply the electric light, they should provide the inhabitants with every information. In reply to this statement, he was informed that this had already been done, so far as the inhabitants in the route were concerned, but the reason that he (Mr. Styler), had received no information was because he was not in the route. *Brighton Society*, thinks this is a beginning of a series of loud complaints against the system of electric lighting adopted by the corporation, as there are thousands of ratepayers who might like to utilise the electric light for the supply of which they are all to pay pretty dearly, but who will eventually be disappointed like Councillor Styler, by finding that they are not in the route. A small minority of ratepayers will have the privilege of using the electric light supplied by the corporation, while the large majority will be denied this privilege, and will have to pay the rates equally with the small minority. This is rather hard on the majority of ratepayers, but it is one of the beauties of the low-pressure system as applied to the needs of a corporation.

Cable Laying.— The work of laying the new cable between Tangiers and Spain has been commenced.

Electric Lighting for Bromley.— Bromley (Kent) is about to be lighted by electricity. Under an order obtained on July 3rd, the Local Board is empowered to supply energy for all public and private purposes within a given area, subject to certain Board of Trade conditions.

Bradford Town Council.—At the monthly meeting of the Bradford Town Council it was stated that the tender of Mr. Wilson Hartnell, of Leeds, for fitting up the Town Hall with apparatus for electric lighting, for the sum of £630, had been withdrawn owing to a mistake having been made in it. The Finance and General Purposes Committee have decided to advertise for new tenders.

A Gigantic Electric Railway Scheme.—From time to time rumours of immense, improbable, and sometimes impossible schemes reach us from the United States, and it would seem that the Continent is now about to tread in the same path. The project is being seriously discussed in Naples of building an electric railway in that city 100 mètres (nearly 350 feet), above the level of the streets. Veritable towers, higher than the first platform of the Eiffel structure, would support the rails. Passengers would ascend by elevators; while as motive power it is proposed to utilise a fall of the Serreno.

The Influence of Lightning and Terrestrial Disturbances on Magnetic Observations.—During the current year at the observatory in the Park of Saint Maur, Mons. Moureaux has remarked several disturbances in the magnetic curves, and has traced them to lightning discharges. Last year these disturbances occurred very rarely, but this year they have been frequently observed. Disturbances of a marked character have also been noticed synchronously with the earthquake shocks which took place in Algiers and elsewhere. Now that these observations have been registered and the cause of the disturbances identified, we may look, in course of time, to the elucidation of the manner how and the reason why they take place, and, perhaps, some valuable information may be eventually forthcoming which will enable these atmospheric and terrestrial disturbances to be predicted.

The Brussels New Post Office.—The telegraph department is to occupy one of the wings of the new Post Office at Brussels. On the ground floor a large room will be used by the public, on the side of which will be placed small rooms for telephones, including apparatus specially arranged for long-distance communication. Telephonic messages will be received by the post office from subscribers. New wires will have to be laid in order to connect the northern and southern systems of telephone lines with the central office; 160 telegraph instruments are to be erected, of which 32 will be of the Hughes type, 100 of the Morse type, and the remainder of the Sounder type; 265 telegraphists will be employed at the new office. The instrument room will be connected with the distributing room by pneumatic tubes. The office will be lighted throughout by electricity.

The Western Counties and South Wales Telephone Company, Limited.—The rental on the establishment of the telephone system in Bristol 11 years ago was £20 per annum for each connection, and covering communication with a very limited number only, whereas the company's rentals are now, for the first business connection in Bristol, a little over half the original rate, *i.e.*, £11 per annum on a seven years' agreement, while all subsequent business connections by the same firm are only £7 each, being an average for two connections of £10 each. At Clifton the rates are £2 per annum lower for first business connections—the rate being, on a seven years' agreement, £9 per annum for each business connection. Private residences may now be joined to the system at rentals from £5 per annum, which low rates, it is hoped, will induce a large number of Bristol, Redland, and Cotham residents to join.

Factory Lighting in Germany.—The benefits derived from employing the electric light in the factories of Germany are said to have been so marked that it is proposed to make the use of it compulsory in all factories where artificial light is employed during working hours.

Catalogue.—We have received from the Consolidated Telephone Construction and Maintenance Company a copy of their illustrated catalogue, which illustrates all the apparatus used for telephonic purposes made by the company. The catalogue is well got up, and printed on excellent paper, and is certainly the best telephone list that we have seen.

Electric Vibrations.—The Danish Academy of Sciences has recently offered a prize of a gold medal of a value of about £17 for an exposition of the theory of electric vibrations in limited and resting bodies in general, with a special application to simple forms of perfect conductors, with the view of solving the mathematical problem which they offer.

Handbook on the Telephone.—Messrs. Whittaker are about to publish a practical handbook on the telephone, dealing specially with telephonic exchanges, by Mr. Joseph Poole, who has been connected with these exchanges since their first establishment in this country. The subject is of particular interest at the present time on account of the expiration of the master telephone patents and the consequent great extension likely to take place in telephonic installations. The book is intended to supply the existing want of a thoroughly practical manual, of moderate size and cost, describing the latest developments of the subject and suitable for the requirements of telephonic *employés* and users of the telephone.

Projected New Cables.—The telegraphic system of one section of the empire has of late been undergoing marked development. Mr. Hosmer, the manager of the Canadian Pacific telegraph system, was in Europe recently, and it is now announced that while here the controlling interest in the Halifax and Bermuda cable was secured by a Canadian syndicate in which friends of the Canadian Pacific Railway Company figure largely. The result will be, Mr. Hosmer says, the laying of some 1,200 miles of additional cable in the near future, while a very material reduction will be brought about in the almost prohibitory rates between the West Indies and Canada, the United States and Europe. Thus, says Mr. Hosmer, "the system will supplement the Canadian Government policy to cultivate trade with the West Indies; for cheap telegraphic rates cannot do otherwise than promote closer and more extensive business relations with the Canadian Dominion."

Cost of Train Lighting by Electricity.—Mr. Timmis has kindly placed at our disposal the following figures:—

Comparative Cost of Train Lighting by Electricity, so far as Batteries are Concerned, per train of 12 *coaches and one van.*

Cost of batteries, with 32-volt lamps, using 1·2 amperes each, 18 cells per vehicle = 234 cells per train, at 30s. each	£350
Ditto, with 50-volt lamps, using ·7 amperes, 27 cells per vehicle = 351 cells per train, at 30s. each	£526

Timmis's Combined System, using 50*-volt Lamps, and Axle-driven Dynamo.*

27 cells in van, at £5 each	£135	
12 small batteries of 3 cells each, or 36 cells in carriage, at 30s. each	£54	
		£189
Add to this extra cost of auxiliary lamps and leads for 13 vehicles, £5 each... ...		£65
		£254

Timmis's system, with axle-driven dynamo, shows a saving per train of £96 and a supply of greater light, or £272 with the same light.

N.B.—If an engine and dynamo are placed on the locomotive, this saving is increased by £135, the cost of battery in van.

The Electric Elevator in Salzburg.—The electric elevator on the Mönchsberg, Salzburg, has now been open to the public about one year, during which time its working has been most satisfactory. During the year upwards of 150,000 persons have taken advantage of this elevator.

Aluminium Production in the United States.—From the bulletin recently issued by the Washington Census Office regarding the production of aluminium in the United States, it seems that electro-metallurgical processes for obtaining this material have become favourite subjects with American inventors. Only two processes, however, have been commercially successful, the earlier of these being the Cowles process, which has already been fully described in our columns. The total aluminium alloys produced by the Cowles Company in 1889 (the latest return made) was 171,759 pounds. The other process is that of the Pittsburg Reduction Company, Pittsburg, Pennsylvania. In 1889 this company produced 19,200 pounds, which was sold at about $2 per pound. The total production of aluminium in the United States in 1889, including that contained in alloys, was 47,468 pounds, $97,335 (£19,567). The production of aluminium in the United Kingdom in 1889 was 12,000 pounds, valued at £6,000.

Andrews's System of Electric Lighting in Liverpool.—An important installation on this system has just been completed at the Waterloo Grain Warehouses, belonging to the Mersey Docks and Harbour Board. The system is already well known to most of our readers, but we may state that one important feature is that the outer or return conductor is of iron uninsulated, forming a substantial protection to the insulation of the inner (copper) conductor, and making, with the solid brass cases of the cut-outs, switches, &c., an unbroken conductor throughout. Switches and cut-outs act only on the centre wire. No wood casing whatever is required. Our favourable opinion of this system has been previously expressed. The dynamo in connection with this installation is of Messrs. W. J. Goolden & Co.'s well-known make. It is driven by a belt from an engine of the inverted vertical marine type, steam being supplied by the main boilers used for the hydraulic system on the Dock Estate. The installation has been carried out to the specification of Mr. G. F. Lyster, the dock engineer, by Messrs. J. D. F. Andrews & Co., 41 and 42, Parliament Street, London, S.W., with the assistance of Mr. W. S. Boult, Assoc.M.Inst.C.E., 60, Castle Street, Liverpool, their sole agent for Lancashire and Cheshire.

Manchester Technical School.—A new department of Physics and Electrical Engineering will be commenced this session at the new branch of the school in Whitworth Street, where a well-lighted warehouse is being fitted, as follows:—Basement: Dynamo house, with dynamos and motors, arranged specially for purposes of instruction. Secondary battery room. Complete appliances for electro-chemical operations, especially nickel-plating and copper deposition. General workshop conveniences for electrical instrument making. Ground floor: Electro-technical museum and advanced physical laboratory. First floor: Lecture room, with conveniences for special experimental illustration. Second floor: Elementary physical laboratory for 40 students. The building will be lighted by electricity, the installation being fitted up with especial regard to purposes of instruction. For the latter purpose, the electric light installation in the central school in Princess Street will also be available. The following appointments have been made:—Chief Lecturer: W. W. Haldane Gee, B.Sc. (Lond.), F.C.S. Assistant Lecturer and Demonstrator: Samuel Joyce, A.I.Elec.E. Mechanical Assistant: Bernard Hunt. In the evening, in addition to the usual course of general physics, special instruction will be provided in electric lighting and power transmission, as well as telegraphy and telephony, the two latter subjects being under the charge of Mr. Taylor, of the Manchester Postal Telegraphs. After Christmas a course of six lectures on electric bells, designed chiefly for plumbers, will be given, and during the summer term lectures and laboratory work, devoted to the study of electro-metallurgy and alternate currents of electricity, have been arranged.

The Electrical Trades Union.—A meeting of the electrical workers was held on Monday evening in Newcastle, for the purpose of enrolling members of the Electrical Trades Union.

Cable Tenders Wanted.—The British Government invite tenders for the manufacture, &c., of the Seychelles-Mauritius Cable. Full particulars will be found in our advertisement columns.

Books Received.—We have received the following books from Messrs. Biggs & Co., 139, Salisbury Court, E.C.:—"A Holiday in a Manor House," by Evelyn Everett Green; "Strange Adventures," by D. S. Sinclair; "Economics of Iron and Steel," by H. J. Skelton.

Dissolution of Partnership.—The partnership hitherto existing between R. P. Eidsforth and Fras. J. Mudford was dissolved by mutual consent from 14th inst., Mr. Mudford taking over the business and all liabilities.

Hove Electric Lighting.—The electric light committee of the Hove Commissioners, met on 3rd inst., and it was agreed to obtain sanction from the Local Government Board to borrow £1,400, that being the amount required for purchasing land and other expenses in connection with the electric lighting.

Personal.—Mr. Charles H. Yeaman, the electric inspector of the Liverpool Corporation, having completed the erection of the electric laboratory of the city engineers' department, and designed and laid down the testing plant, has resigned his position as city electrician and has, we are informed joined a company as engineer. There are already 75 applications for the position vacated by him.

City and South London Railway.—After a European trip Mr. R. S. Dobbie, an electrical engineer of the Edison General Electric Company, has just returned to America. During his visit he not only travelled over the City and South London Railway, but devoted considerable time to a careful investigation of its workings. "There is," said he, "no question as to its success from the passenger's standpoint."

Inverness and the Electric Light.—At a meeting of the Inverness Police Commissioners on Monday last, attention was directed to the report of the gas manager, in which he stated that owing to the yearly increasing consumption of gas in the town additional machinery and holders would be required at the gasworks, and he estimated the cost at about £10,000. Before embarking on such a heavy expenditure, it was thought the Commissioners should consult an engineer on the subject of lighting the town by electricity. It had been suggested that the necessary motive power might be obtained from the river or from Loch Ness, or even from the Fall of Foyers. The motion was unanimously adopted.

Electrical Development in Canada.—It is hoped that the Convention of the National Electric Light Association in Montreal will stimulate a more general interest in all electrical matters throughout Canada, a country possessing natural advantages which render it a magnificent field for the application of electricity generally. There are splendid water powers available which at present are practically wasting. Prominent men in Canada state that there is a large and profitable field of labour for American electrical companies in the Province of Quebec. They go so far as to state that when the facts are generally realised electrical companies will do a great deal of missionary labour in the field, and will be ready with their capital to build factories for the construction of electrical apparatus in Canada. Power is required in Quebec, not only for lighting and general manufactories, but it is also needed in the eastern townships for operating the mines. Waterfalls are available, and only an effective system for transmitting the power to the mines is needed.

Haslingdon and Electric Lighting.—The Haslingdon Local Board have appointed a sub-committee to enquire into the cost of putting down and maintaining the electric light in the town.

Dufftown Lighting.—A public meeting of householders of Dufftown on Monday unanimously agreed to authorise the Police Commissioners to purchase the gasworks, but to ask them to take the opinion of an expert as to the cost, &c., of introducing electric light.

New Submarine Cable.—A San Francisco telegram, despatched on September 15th, reads as follows:—"The United States steamer, *Albatross*, arrived here last night, and proceeded to Mare Island this morning. She is making surveys for a cable between this port and Honolulu."

Denbigh Lighting.—At a meeting of the Denbigh consumers of gas, on the 11th inst., it was resolved that if the gas company declined to make a reduction in the price they would at the next meeting consider the advisability of lighting the town by electric light.

Malvern and Electric Lighting.—At a meeting of the Malvern Local Board, on Tuesday last, a letter was read from Messrs. Griffiths and Millington, of Worcester, asking upon what terms the Board would be prepared to sell the right they had obtained to supply the town with the electric light, and a decision upon it was deferred.

Dover Town Council.—At the last meeting of the Dover Town Council, a letter was read from the Brush Electric Lighting Company, in which they proposed to form a local company, and to light the town with electricity. After discussion, it was decided to circulate the letter, and adjourn the matter for consideration at the meeting of the managing committee, to be held in a fortnight.

Opening of Brighton Central Station.—On Monday last the Brighton Town Council inaugurated their electric lighting works, and henceforth will be prepared to supply the electric light to residents in a large portion of the town. The system of the cables is the low pressure one. The ceremony of switching on the light was performed by the Mayoress (Mrs. Soper), the Mayor presiding, and there was a large gathering of townsmen. Councillor Moon, chairman of the lighting committee, when proposing a vote of thanks to the Mayor and Mayoress, stated that, as members of the lighting committee, they had no doubt as to the ultimate success of the undertaking. They did not want to make so much profit after they had paid off the capital and interest, but to give the benefit of the remainder to the ratepayers in a good light and in reduction of cost.

Accident on the Portrush Electric Railway.—An accident occurred on Sunday last on the Giants Causeway Electric Tramway. A steam tram left Portrush and an electric car left the Causeway, both at the same time, they usually pass one another a short distance to the east of Dunluce Castle, and the tram arriving there first should wait until the other passes. It is said, however, that on this occasion the steam tram arrived first and passed on without waiting. Some distance further along the line the electric car was coming, and the passengers became very alarmed, both conveyances being on a single line of rails. Amid the excitement several of the passengers leaped off the car; one gentleman fell and was partially stunned, while his wife also fell and was very seriously injured, the doctors considering her recovery impossible. Neither of the cars were damaged, however, as they were brought to a standstill just as they touched each other, a serious collision being very narrowly averted. The driver and conductor of the steam tram were arrested. It is perhaps too easy to give advice after such an accident, but it seems a pity that the passengers were not prevailed upon to keep their seats. If the case as stated represents the facts, there has been gross carelessness on the part of the *employés* of the company.

Electric Motors.—In answer to several correspondents we may say that Mr. Rankin Kennedy, of Glasgow, is a maker of motors without commutators. See Correspondence columns.

The Electric Light in Denmark.—The new railway station at Elsinore, in Denmark, which is now approaching completion, will be lighted throughout by means of electricity.

Accumulators.—According to *Der Electro-Techniker*, no less than 800 patents have been granted to the present time in the United States in connection with accumulators and their details.

Central Electric Power Station for Hamburg.—The Hamburg Senate are open to receive proposals for the erection of a central station for the distribution of electrical energy throughout Hamburg.

African Telegraphs.—Some idea of the falling off of interest in South African affairs is gleaned from the fact that, while for the year 1889-90 the Cape telegraph revenue amounted to £81,004, in 1890-1 it only reached £69,627.

Theatre Lighting.—The inauguration has just taken place of the electric lighting of the Hamburg Municipal Theatre. There are installed about 3,200 glow lamps, and the main feature of the installation is the fact that to ensure absolute reliability current can be supplied from three sources, either independently or combined.

The Electric Light in a Bournemouth Church.—Holy Trinity Church, Bournemouth, is about to be lighted by electricity. This decision was arrived at by the Vicar (the Rev. Canon Elliott), the churchwardens, and the sidesmen, at a meeting held last week. The system adopted is to be similar to that at the Temple Church, London.

The Electric Light at Bodmin.—At a meeting of the Cornwall Borough Council last week several letters were read from electric lighting companies, accompanied by estimates for erecting and carrying on electric works. Mr. Veale (St. Austell Electric Works), estimated that the cost would be £3,550 if worked by water power, and £2,900 by steam power, the annual cost of working being £150. The communications were referred to the Lighting Committee.

The Electric Lighting Works in Dublin.—The building operations connected with the Corporation electric lighting station are not progressing so rapidly as was anticipated. In our issue of June 26th last, we stated that it was confidently expected that the thoroughfares would be lit by electricity about November this year, but from the present appearance, the fulfilment of such an expectation may be regarded as an impossibility. It is said that of late the building operations have not been proceeded with as rapidly as might be desired, but with increased vigour, the accomplishment of the fact may be expected to date about February next year. The contract between the Corporation of Dublin and the Electric Engineering Company was signed on Saturday last. The work of laying the mains will be commenced immediately.

New Cable Wanted.—The necessity of establishing telegraph communication with Sandy Point and the other settlements in the Straits has again been brought forcibly before the Chilian Government. In 1889 estimates were invited for laying the cable—some 1,300 miles long—but here the matter dropped, although the proposition to lay the cable had been raised through a vessel having foundered in the Straits of Magellan, and no news of the accident reaching the only civilised place in the Straits until 14 days after the disaster. Another precisely similar maritime disaster very recently overtook the *Cotopaxi* in the same straits. No lives were lost, but the news as before, which was received *viâ* London, was a long time reaching civilised parts. It is to be hoped that when the present little trouble is over, the matter will be taken up without delay.

Rival Illuminants in Berlin.—Notwithstanding the extension in electric lighting in this city, the consumption of gas continues to increase. There are already four municipal gas works, and now a fifth is about to be built near Schmargendorf to cope with the demand.

Plymouth and Electric Light.—The Plymouth town council are appointing a sub-committee to confer with the Engineer of the Devon and Cornwall Electric Lighting Company with reference to the lighting of the borough with electric light; and also to invite tenders for the said lighting.

Falmouth Lighting.—At the annual meeting of the Falmouth Gas Company held last week, the chairman in answering Mr. Grose, said that the company would take no steps regarding the proposed syndicate for supplying the electric light in the town.

Electric Lighting in Chelsea.—At last Friday's meeting of the Chelsea Vestry, a special vote of thanks was accorded to Mr. T. Holland (vestry clerk), for the successful manner in which he recently conducted their case before the House of Lords with regard to the Chelsea Electric Lighting Order, 1891.

Electric Lighting in Eastbourne—Reduction in Price.—Referring to our note of last week under this heading, we are requested to state that the lamps offered by the Eastbourne Electric Light Company, Limited, were similar to those which have been burning on the sea front at Eastbourne for some years, and are of 2,000 nominal candle-power.

Proposed Electric Lighting at Accrington.—At the last meeting of the Accrington Town Council the Town Clerk stated that he had received full reports of the recommendations of engineers from over 20 boroughs as to the best system to adopt for electric lighting. These reports were of great value, and as soon as they had been circulated amongst the members of the committee they would have a good idea as to what method to adopt.

The Electric Light in Kilkenny.—A banquet was given on Monday night in the Clubhouse Hotel at Kilkenny, to celebrate the introduction into the establishment of the electric light. The Chairman, in the course of the evening, stated that in a short time a proposal would be made to the corporation of Kilkenny for the purpose of having the city lighted by electricity, and he hoped the members of the corporation would not be backward in that respect. Finally a date was arranged for holding a special meeting to consider the matter.

CITY NOTES.

The Petroleum Engine Company, Limited.

THE following is the directors' report to be submitted to the meeting of shareholders to be held on September 25th, 1891.

The accompanying accounts show that the royalties received for the year ending June 30th, 1891, amount to £1,053 7s. 6d. This is a smaller sum than the prospects at the commencement of the financial year gave ground to expect, but the reasons may be clearly traced. In July, 1890, the Royal Agricultural Society held a competitive trial at Plymouth for liquid fuel and hot-air engines, at which the Priestman oil engine took the highest and only award. This, following on the previous awards of the Royal and other societies, and the adoption of the engine in many influential quarters, proved to the manufacturers of steam and gas engines that they had a formidable rival in the oil engine, and led to vigorous opposition. Some engine manufacturers issued circulars informing their agents throughout the kingdom that they were about to bring out a petroleum engine, and advising intending purchasers to wait before ordering. This had its effect in keeping back orders, and for some months the satisfactory increase in the returns mentioned in the last report was checked.

At the last Royal Agricultural Show held at Doncaster, though there were several petroleum engines shown, only one firm ventured to enter for competition. They, however, failed to obtain any award

and it is most gratifying to the directors to be able to report that since that time orders for the Priestman engine have come forward most satisfactorily, and far beyond anything recorded in the previous history of the company.

During the year the engine has gained a gold medal at the Edinburgh Exhibition, and also a gold medal at the Glasgow Industrial Exhibition. Engines are now running at the Royal Naval Exhibition, the Taunton Electrical Exhibition, and the Crystal Palace.

The directors think it desirable, in view of a circular recently forwarded to the shareholders by Mr. J. C. Stovin, to recall briefly the position of the company with regard to Messrs. Priestman Brothers, and also to correct the impression which the circular has conveyed, that Mr. Stovin's name has been kept off the register of shareholders through the action of the directors. The legal proceedings in the High Court of Chancery, to which he refers, were not against the company nor any of the directors; but, as the directors are informed, they were against one of the promoters of the original company, with whom he had disagreed respecting the division of profits derived from the sale of the original patents, to a share in which profits Mr. Stovin claimed to be entitled.

The circular further implies that the directors had in contemplation some alteration of the agreement which the shareholders, after the fullest consideration at a special meeting convened for the purpose, and held in London in the early part of 1889, authorised the directors to enter into with Messrs. Priestman Brothers.

There has never been any intention on the part of the directors to alter that agreement, and the shareholders may rest assured that if it were possible or expedient to vary it, they would again be called together and consulted before any variations were made, more especially as Messrs. Priestman Brothers have given practical proof of their readiness to spare no effort to develop the invention by extending their premises and plant, and keeping on hand a large stock of engines in a forward state to meet promptly the growing demand.

All practical engineers know that a new invention of the nature of a petroleum oil engine requires constant and personal attention as to details, in order to make it a saleable article, and also the expenditure of a large amount of capital to introduce, advertise, and push its sale. Messrs. Priestman Brothers have throughout acted in the most straightforward and honourable way in bringing out, developing, and pushing this invention, and the imputation conveyed in Mr. Stovin's circular, that they have taken advantage of their position to secure controlling patents to the disadvantage of the company, is without a vestige of foundation. The whole of the patents for Great Britain and her colonies, connected with the engine, are the company's property, and there are provisions in the agreement with Messrs. Priestman Brothers for granting sub-licenses for certain types of engines.

The directors, who represent, and have been elected as, an independent board by those shareholders who put their cash into the company, would urge the proprietors to make an effort to be present at the general meeting, and not to give their proxies in favour of a policy which could have no other practical result than again to hand the management over to the original promoters and those claiming under them.

The amount standing to the credit of the revenue account, including the amount brought forward from last year's account, is £918 1s. 11d. From the increase in the royalties earned since the close of the financial year, the directors feel justified in recommending the declaration of a dividend on the 18,754 shares in the company at the rate of 9d. per share, free of tax, for the year ending June 30th last, which will absorb £738 7s., carrying forward the balance to next year's account.

The retiring directors are Mr. Jarvis W. Barber and Mr. Charles B. B. McLaren, who offer themselves for re-election. The secretary has received a notification from Mr. J. C. Stovin, of the National Conservative Club, Pall Mall, London, S.W., that he intends to offer himself as a director.

The auditors, Messrs. E. L. Ernest & Co., retire, and are eligible for re-election.

BALANCE SHEET, *June 30th*, 1891.

Dr.	£	s.	d.
To nominal capital—			
20,000 shares of £5 each	100,000	0	0
„ 9,654 shares of £5 each fully-paid, agreed to be issued to shareholders in the old company ...	48,270	0	0
„ 9,100 shares of £5 each fully-paid, issued in purchase of moiety of British and colonial patents, and the patents for India and Canada	45,500	0	0
„ Sundry accounts	906	1	5
„ Balance of income and expenditure	918	1	11
	£95,594	3	4

Cr.	£	s.	d.
By Capital expenditure as per last account, in purchase of Eteve's, Humes's and Priestman's patents for the United Kingdom and British colonies, including India and Canada, and expenditure in connection therewith	94,747	1	8
„ Patent fees, law charges, patent agents and engineer...	304	4	8
„ Sundry debtors	373	6	10
„ Office furniture	9	16	0
„ Cash in hand and at bankers	159	14	2
	£95,594	3	4

INCOME AND EXPENDITURE ACCOUNT, *June 30th*, 1891.

Dr.	£	s.	d.
To rent of office and secretary's salary	130	0	0
„ Miscellaneous expenditure, including travelling expenses, printing and stationery, &c.	46	5	8
„ Auditors' fees	5	5	0
„ Directors' fees...	400	0	0
„ Balance	918	1	11
	£1,499	12	7

Cr.	£	s.	d.
By Amount from last account	440	14	7
„ Royalties from sale of engines for the 12 months ending June 30th, 1891	1,053	7	6
„ Transfer fees	4	5	9
„ Miscellaneous receipts	1	5	6
	£1,499	12	7

The Brush Electrical Engineering Company, Limited.

THE second annual report of the directors to be presented to the shareholders at the general meeting of the company on September 25th, 1891, has been issued. It states that the profit and loss account shows a gross profit of £42,712 8s. 10d., inclusive of the amount brought forward from last account, but exclusive of any profit derivable from the City of London electric lighting undertaking. After deducting all standing charges, &c., maintenance of plant, buildings and patents, and interest on debentures, there remains a balance of £19,354 2s. 1d. It is proposed to apply £630 to reduction of preliminary expenses, and to reduce property, patents and goodwill account by £3,000. An interim dividend, absorbing £4,199 15s. 2d., has already been paid upon the preference shares for the six months ended December 31st last, and it is proposed to apply £4,199 15s. 2d. to the payment of a further dividend upon these shares, making up the full preferential dividend at the rate of 6 per cent. per annum. The directors further recommend that a dividend be paid upon the ordinary shares of the company at the rate of 6 per cent. per annum for the half-year ended June 30th last, and that the balance of £306 11s. 5d. be carried forward to next account. It is proposed to make the dividends on both the preference and the ordinary shares payable on 1st October next.

The Direct Spanish Telegraph Company, Limited.

THE directors' report for the half-year ended June 30th, 1891, states that the accounts for the half-year ended June 30th, 1891, show, after providing for debenture interest, a balance to the credit of profit and loss of £5,525 16s. 10d.

The traffic receipts show a decrease of £1,620 10s. 6d. as compared with those for the corresponding half-year of 1890. The falling off in the receipts is principally attributable to the comparative failure of the early fruit crop in Spain, owing to the severe frost, and to the iron ore trade having been adversely affected by the strikes in England and at Bilbao. The working expenses are £284 11s. 9d. in excess of those for the corresponding period of last year.

With the exception of the interruption of the Barcelona cable from April 3rd to 14th, the company's cables and the land-lines in connection with them have continued in good working order throughout the half-year.

The entire cost of the repairs of the Barcelona cable, amounting to £1,695 1s. 2d., has been paid out of the "Contingencies Account." Of the balance of profit and loss, £2,500 have been put to the reserve fund (which now amounts to £25,928 7s. 8d.), leaving a balance of £3,025 16s. 10d. Out of this amount the directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 5 per cent. per annum (free of income tax), on the ordinary shares. This will admit of a sum of £270 4s. 10d. being carried to the "Contingencies Account."

The dividend warrants will be issued on October 1st, 1891.

International Okonite Company, Limited.—The first ordinary general meeting of shareholders of the International Okonite Company, Limited, will be held at the Cannon Street Hotel, City of London, on Friday, the 9th October, at 12 o'clock.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended September 11th, amounted to £4,430.

The City and South London Railway Company. Traffic receipts for the week ended September 13th, amounted to £664.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 11th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £2,971.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Sept. 10th.)	Closing Quotation. (Sept. 17th, 1891.	Business done during week ending (Sept. 10th, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48 — 49	49 — 50	49	48½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	86½— 87½	87½— 88½	88	87
2,849,510*l*	Do. do. Deferred	Stock	13½— 14	14 — 14½	14½	13⅝
130,000	Brazilian Submarine Telegraph, Limited	10	11⅝— 12¼	11⅝— 12¼	12⅛	11⅝
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102	99 —102	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅝— 2⅞	3⅛— 3⅜	3 11/16	2⅝
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 2⅛	2 — 2¼	2	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	109 —111	117 —120	119	114½
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16 — 9/16	7/16 — 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4½— 5½	5 — 5½	5¼	5
16,000	Cuba Telegraph, Limited	10	10 — 11	10 — 11	10⅝	10⅜
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3½— 4	3⅝	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	10½— 11½	10½— 11½	11	10 15/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14½— 14⅝	14½— 14⅝	14⅝	14½
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	107½	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	108⅝	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	104⅝	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	107⅞	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —102	99 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4½— 4⅝	4⅝— 5¼	5	4 13/16
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3⅛— 3⅜	3⅜— 3⅜	3⅛	3⅛
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	4⅛— 4⅜	4⅛— 4½	4⅜	4
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	2⅝— 2⅞	2½— 2⅝	2¾	2⅝
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜— 9⅞	9⅜— 9⅝	9⅝	9 9/16
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18⅝— 19½	18⅝	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107 xd	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	19½— 20½	20 — 21	20½	19⅝
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	42½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7⅛— 8⅛	7⅛— 8⅛	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9⅝	9¼— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7⅛	6⅓— 7⅛	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	104 —107 xd	104 —107	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅝— 10⅛	10 — 10⅛	9⅝	...
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅞	4½— 4⅝	4⅝	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½—13½	12½— 13½	13¼	12⅞
15,600	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12½— 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	106 —108	106 —108	107½	106⅝
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	4⅛	4
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
9,000*l*	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7 — 7½	8 — 8½	8¼	7 5/16
7,900	Do. do. do. 7 per cent. pref.	2	4½— 5	4½— 5	5	4⅝
3,381	Submarine Cables Trust	Cert.	120 —125	120 —125	122½	121½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4⅜— 5	5⅛— 5	5⅛	4 15/16
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43⅝	42⅝
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2½— 3½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	96 — 99 xd	96 — 99	99	...
30,000	West Coast of America Telegraph, Limited	10	3¼— 3⅝	3½— 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102	97 —102	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10⅞— 11¼	10⅞— 11¼	11⅛	11 1/16
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	7	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4½— 4⅞	4½— 5	4⅝	4⅝
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105	102 —105	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅞— 2	1⅞— 2	1 15/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9⅞— 10¼	9⅞— 10¼	10¼	9⅞
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	8 9/16	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102 xd	98 —102	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5¼—5⅝	5⅝— 6¼	6	5⅛

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Ordinary of £10 each, £4 paid, 4—4½.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem., fully paid, 1—1¼.—Elmore's Priorities, 3⅞—4⅛.—House to House Company (£5 paid) 4½—5.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅝—1⅞.—Manchester, Edison and Swan Company, £9 (£1 paid) ¼ — ⅓.—National Telephone Debentures, 2½ — 3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3⅞—4.—Debentures 90—95.—Wards Electric Car, £10 paid, ⅞—1.

BANK RATE OF DISCOUNT.—2½ per cent. (2nd July, 1891).

THE DYNAMOS AT FRANKFORT EXHIBITION.

By W. B. ESSON.

I.

THOUGH the Frankfort Exhibition can scarcely justify its claim to internationality, it without doubt forms the most interesting and instructive collection of engines, dynamos, and general electrical plant ever brought together. In character this collection differs greatly from that in the Paris Exhibition of '89.* At the latter the machines were comparatively small, and the largest was one of the Siemens and Halske interior magnet pattern, exhibited by the Société Alsacienne de Constructions Mécaniques, which gave an output of 125 kilowatts at 150 revolutions per minute. This machine was one of the few in the exhibition driven directly, and was coupled to an Armington and Sims horizontal engine of 150 horse-power. Amongst the belt-driven machines will be remembered the four-pole Oerlikon, giving 180 kilowatts at 480 revolutions, and the Thury, giving 105 kilowatts at 360 revolutions.

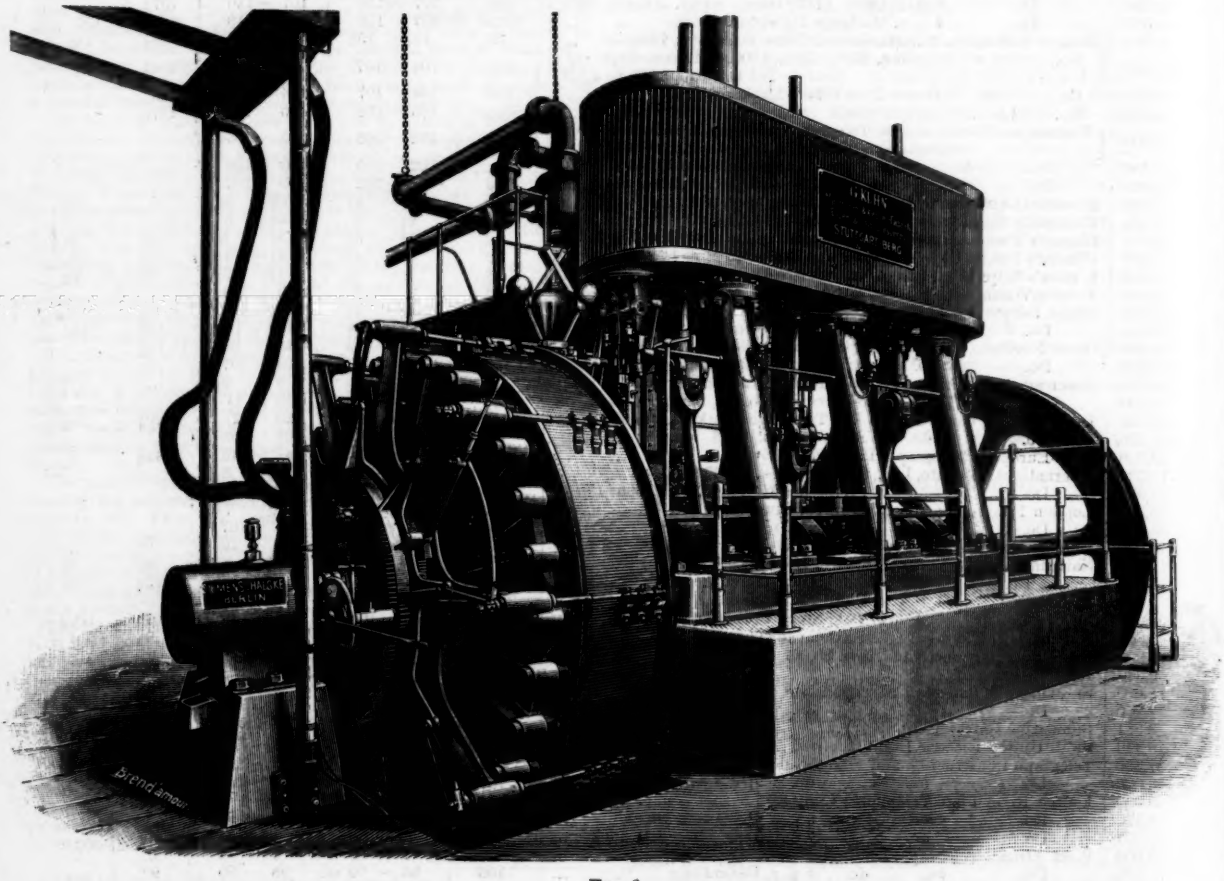


FIG. 1.

These were the largest direct current machines shown in '89, and of alternating current ones there was a remarkable dearth. But at Frankfort we have machines both direct and alternating, with an output closely approaching three times that of the largest shown in Paris. Most of the machines from 100 kilowatts and upwards are coupled direct to open-fronted inverted engines of the marine type. They are all of multipolar design, and generally constitute splendid examples of central station engineering. But it seems that they are not always looked upon by our engineers as examples to be followed, since, in this country, the largest machines have been of the two-pole type, and driven by single-acting engines at considerably higher speed than would be permissible with the continental engines for the same power.

In the central stations of London may be found several two-pole machines, giving 120 kilowatts, and running at 350 revolutions per minute, the largest machines yet constructed in England running at this speed. These latter, of the single-magnet pattern, give an output of 180 kilowatts (1,500 amperes by 120 volts), and have been at work for some time at the Naval Exhibition. For comparison it may be mentioned that they have armatures 24 inches in diameter and 36 inches long, wound with two separate circuits of 36 convolutions each, which circuits are put in parallel by the collecting brushes. The commutator has 72 segments, one for each convolution.

The speed for continental machines of this latter output, coupled direct to double-acting engines, would be about 175 revolutions per minute, or half that at which they are now driven, while the machines themselves would probably have four or six poles. It is instructive to effect in imagination a metamorphosis, transforming from the English to the German pattern. First let us cut the above-mentioned Siemens machine in two, crossways, making the armature 18 inches long instead of 36 inches. Next let the diameter of the armature be doubled, making it 48 inches instead of 24. The armature so modified will now give 180 kilowatts at 175 revolutions per minute. We may put on four exterior poles, as from the single horseshoe we have cleft in two we get two horseshoes which will fit the armature, now half its former length. Roughly, in the metamorphosed machine the weight of the armature core has been increased from 20 to 25 per cent., while the weight of the field magnet system remains about the same. The copper on the armature has been increased by probably 25 per cent., and the copper on the magnets by perhaps 75 per cent. But the result is that we have now a machine which at half the speed gives the same output as the original one with the same efficiency, and our figures consequently show that in replacing the two poles by four the cost of the dynamo is increased at nothing like the inverse ratio of the speeds, while the compound double-acting engine for driving it, notwithstanding the slower speed, costs no more than the compound single-acting one. The choice between the two

* See "Notes on the Dynamos at the Paris Exhibition," by the writer. ELECTRICAL REVIEW, vol. xxv., pages 36 *et. seq.*

classes of machinery just mentioned must, of course, be made after balancing up the advantages and disadvantages of each. Comparison is here instituted merely to show that continental makers may have acted not without reason in going in almost exclusively for multipolar machines and medium speed engines for their central stations.

Passing through the main entrance of the large machine hall, we find the exhibit of the Helios Company occupying the central place, while the firms of Siemens and Halske and Schuckert & Co. occupy, with their magnificent displays, leading positions at opposite ends of the building. Amongst firms exhibiting, whose names are more or less familiar to English engineers, are, besides the above, Lahmeyer of Frankfort, Fritsche and Pischon of Berlin, Kummer of Dresden, and Fein of Stuttgart. All these have a fairly good show, some of them better than others, but none approaching in size the displays of the three first named. These, the Helios Company, Siemens and Halske, and Schuckert, have put down each a central station of no small capacity, and within the precincts of the machine hall can be studied at leisure all the systems of central station distribution as yet in use.

The multipolar design adopted almost exclusively for machines of large size is well represented by the direct driven interior pole dynamo of Siemens and Halske, which is the largest yet constructed, shown in fig. 1. This machine runs at a speed of 80 revolutions per minute, and gives 2,000 ampères at a difference of potential of 150 volts, or an output of 300 kilowatts. It has a ring armature of 300 cm. outside diameter, Gramme wound, with 810 convolutions. The winding is of solid copper bars, the outside and inside sections being united together at the circumferential corners by riveting and soldering. The bars on the exterior of the ring, rather over 1 centimetre wide, are separated from each other by compressed paper, and form the commutator of the machine, the current being collected by 10 sets of brushes 4·5 cm. wide, three in a set. The brushes are made of rectangular copper wire strands laid several side by side, and soldered together at the outside end. Their pressure can be adjusted independently while the machine is running, and provision is made for altering their position on the ring, or lifting them simultaneously by simply moving the controlling levers visible in the figure. Alternate sets of brushes are connected together, and the current flowing through the armature in 10 parallels is carried off by two thick flexible cables as shown. The armature core is built up of thin iron plates, and is supported by 30 steel bolts carefully insulated, which project from a strong star-shaped centre-piece of cast iron keyed to the shaft. There are ten radial magnets having a width of about 50 cm., and cast in one with a heavy central yoke ring. The diameter of the magnets over is 272 cm. The machine is shunt wound, the magnetising coils being 36 cm. long, and one on each magnet. The yoke ring carrying these radial magnets is bolted to the engine bed-plate, and the armature is secured to the engine crank shaft, the latter being continued through the cast iron centre without coupling. The engine, by Kuhn, of Stuttgart-Berg, is of the triple expansion condensing class, with three cranks set at 120°, the high pressure cylinder being next to the armature. The cylinders, all steam jacketed, are 50 cm., 77 cm., and 120 cm. diameter respectively, and the stroke is 60 cm. Steam is admitted by piston valves to the high pressure cylinder and by balanced slides to the medium and low pressure. The engine proper has six bearings, one outside the flywheel, one between the flywheel and the low pressure cylinder, two between the low pressure and medium pressure, one between the medium and high pressure, and one outside the high pressure. Outside the armature comes another bearing, making seven in all, this latter being bolted to a heavy cast iron standard which is planed on the bottom, bedded on and bolted to planed rails set underneath the level of the armature circumference. By removing the flooring boards in front and slacking the bolts, the standard with the bearing and brush gear can be moved on the rails right away from the shaft by a screw, thus leaving the armature fully exposed for examination. All the bearings with the exception of this outside one, which is 66 cm. long and self-adjusting, are lined with white metal in the ordinary way. The shaft is 26 cm. diameter throughout, excepting where the armature centre is keyed on, being swelled there to 35 cm., and at the bearings on each side of the armature, where it is 30 cm. The distance from centre to centre of these two bearings is 240 cm. To the outside bearing is bolted the ring supporting the brush carrier, the ten radial arms of which are clearly shown in the figure. The machine at 100 revolutions per minute gives a difference of potential of 200 volts, and as the armature will easily carry 3,000 ampères, an output of 600 kilowatts is reached at this speed.

Messrs. Siemens and Halske exhibit several directly-coupled dynamos for ship-lighting, of similar type but of small size. These are provided with a separate commutator built up of iron segments, to which the ends of the armature sections are led, a construction which obviously becomes necessary when the section of the conductor gets inconveniently small and the convolutions numerous. Generally the small machines of this pattern have four interior poles.

There is also shown a number of upright pattern single-magnet drum armature machines (fig. 2), ranging in output

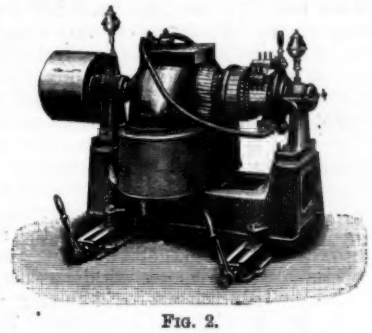


FIG. 2.

from 1,300 watts at 1,200 revolutions per minute, to 80 kilowatts (535 ampères by 150 volts) at 550 revolutions. The smallest has an armature of about 15 cm. diameter, while in the largest the armature is 40 cm. diameter, and the commutator has 40 segments. In these machines the magnets are of cast iron having a D section, the flat sides facing each other. The commutator segments are of iron firmly secured by screws at one end, and overhanging with an air-space between each, no further insulation being needed. It is said that these commutators last most satisfactorily, ordinary copper wire brushes being in all cases used with them.

(To be continued.)

THE INTERNATIONAL ELECTRICAL CONGRESS AT FRANKFORT.

[BY A SPECIAL CORRESPONDENT.]

IN spite of the rather national character of the Electrical Exhibition, the Congress which has just been held on the banks of the Main was thoroughly international and fairly representative as far as the various branches of electrical science and industry are concerned. The committee of the Frankfort Electrotechnical Society rejoices in the unqualified success of this great gathering. Up to September 9th, 682 gentlemen connected with electricity in all its applications have joined the Congress; of these there are 42 from England, amongst whom I noticed Mr. W. H. Preece, Prof. Ayrton, Dr. Silvanus P. Thompson, Professor George Forbes, Mr. Gisbert Kapp, Mr. R. E. Crompton, Mr. Henry Edmunds, Mr. Pell, Mr. A. R. Bennett, Mr. A. Reckenzaun, and a number of other well-known electrical engineers. Belgium sent 13; Denmark, 5; the United States, 8; France, 15; Holland, 12; Italy, 19; Austria, 59; Russia, 14; Switzerland, 26; Scandinavia, 14; and Germany, 455. Papers were read, lectures given, and discussions conducted in the German, English, French and Italian languages. The foreigners who enjoyed the most enthusiastic receptions at the sectional meetings as well as at the various social gatherings were Dr. S. P. Thompson of London and Professor Ferraris of Turin; but the lion of the party was, of course, Dr. Werner von Siemens. The Germans have a peculiar method of conducting their meetings, indeed the reception on the 7th inst. may be characterised as a perfect pandemonium. It was held in the large restaurant, the general public had access to it, there were no presentations except incidental mutual introductions.

The president was surrounded by a great crowd, and there was loud conversation going on all round, which was almost deafening when the clatter of beer glasses and "Krügel" commenced. Much beer and Rhine wine were essential features of all the social reunions.

The business proceedings of the Congress were opened on Tuesday morning by the Secretary of State, His Excellency von Stephan who greeted the members with an eloquent speech. He said that the very large number of participators in this Congress was a positive proof of the popularity and even necessity of such gatherings. The government and the German Emperor had taken great interest in the proceedings of the meetings, and the Imperial Chancellor was following all that appertains to the progress of the electrical industry with marked attention. His Excellency referred to the first international congress of electricians at Paris, where the determination of electrical units on an international basis formed the main business. Although the present Congress continued these labours, it occupied itself with a very wide field comprising the recent progress of every branch of electrical science. Electrical installations spread themselves over the old world as well as the new; important purposes of civilisation are thereby being satisfied; capital finds new sources of useful application; a vast amount of intellectual and manual labour finds new employments; and existence is made more interesting whilst science is promoted at a rapid rate. He expressed his gratitude to the leading men of all nations, who have through the conception of grand ideas, and the results of earnest work contributed to the many discoveries and to the investigations of their laws now so well known. That these great advances within a comparatively short period form an inducement to still further progress is evidenced by the present Electrical Exhibition. The speaker warned his audience against overestimation of the results already obtained, so that the solution of still greater and even more difficult problems should not be retarded. The onslought upon our coal supply is enormous; the consumption of coal increases at an alarming rate, and the question before us will be whether by a new method of transforming heat energy into electric energy we may obtain a vastly higher efficiency and thereby reduce the chance of an exhaustion of our coal supply. A very long time may elapse before we shall be able to utilise the sun's rays as a more direct source of energy than geological evolution, but the aims and resources of the human mind are incalculable. One thought, said Herr von Stephan, he wished to give expression to, and that was whether all the existing electrical enterprises, and still more, whether all the projected schemes, did not contain some which were prompted by a speculative initiative, or in how far they were a real necessity of the times; whether it might not produce overproduction in a certain direction, and bring with it too much luxury and increase in the cost of living. He admitted that in many cases speculation has been the main spring of enterprise, also that competition has had beneficial effects; nevertheless, the taking of much liberty with the economical resources brings with it peculiar responsibilities and duties. The appearance of a new idea or a new form of energy is almost invariably accompanied by new disadvantages; but these are generally got over without lasting damage to the grand total of the world's organism.

After this opening address, the elections of officers took place. Dr. Werner Siemens was elected President; Mr. W. H. Preece of London, M. Hospitalier of Paris, Prof. Ferraris of Turin, Prof. W. Kohlrausch of Hanover, and Prof. von Waltenhogen of Vienna, were chosen Vice-presidents, as notified last week.

The afternoon was occupied with the reading and discussion of two interesting papers. The first of these was given by Professor Kohlrausch, entitled "What is the best method of training electricians?" The learned professor distinguished between three categories of students, namely, those who intend to devote themselves to electric science alone; those who study mechanics and engineering before the electrical branch; and, finally, those who after passing through physical sciences, add to it a thorough theoretical knowledge of electricity.

In order to obtain the views of members present, Prof. Kohlrausch gave the curriculum which he followed during four years for higher schools. After an advanced study of mathematics and drawing, great value is set upon physics, especially the theory of magnetism and electricity; to this is to be added a knowledge of the most usual machines. A study which is well worth attending to is chemistry, as it opens a wide field of application. Mechanical engineering should be learnt, but as it is a very wide field, the lectures should only embody the most essential branches. Workshop practice is a most important one and opens the question of the kind of workshop most suitable for the needs of the student. The Professor wished particularly to ascertain the views of manufacturers, what sort of training they would most appreciate in an employé.

Dr. Slaby, in opening the discussion, declared himself in favour of the lecturer's scheme, with one reservation, and that is that every student of mechanical engineering should have opportunities to get a good knowledge of electrical engineering. In any case a young man should decide at once whether he desires to become a physicist or an engineer; in the latter case he ought to work in a large engineering works first, and attend the technical high school afterwards.

Dr. Werner von Siemens declared that the technical high school should only provide as much electrical science as will be necessary for the special branch, because electrotechnics is not a distinct subject forming a whole in itself, it is rather a science auxiliary to other technical studies. The demand for practical engineers is much greater than for so-called scientific electricians who require a special kind of training.

Mr. Hartmann advocated practical workshop training which should be supplemented by a year's study in a high-class school.

Mr. Rathenau agreed with the suggestion of Dr. Slaby; at least two years should be spent in workshops.

Dr. Silvanus P. Thompson, who was most enthusiastically cheered, next gave his paper, delivered in good German, on "The New Domain of Alternating Currents." He first dwelt upon the history of alternating currents from Faraday's experiments in 1831, supplemented by the investigations of Gauss, Weber, Maxwell and Lodge, up to the gigantic work of Ferranti who has built dynamos of 4,500 H.P., having armatures of 45 feet diameter.

The alternating current motor is rapidly being developed, and the present Electrical Exhibition in Frankfort marks the history of the multiphase current which is so much admired in the example of the Lauffen electric transmission, especially by foreigners. The alternating current has opened up a glorious land, upon which no man's foot ever trod, and which offers the investigator an unlimited field of activity. Innumerable tasks await completion, which lie within the limits of possibility of practical application. Seeing by electricity will probably be accomplished with the same certainty as hearing is now; the electrolytic effects of alternating currents have received little attention as yet; octoplex telegraphy, multi-telephony on one wire, telegraphy and telephony without any wires, ocean telephony, and many other inventions will yet be made. In the wave theory of electricity lies the future of electrical science and its applications.

The deliberations of the Congress took place in different rooms, and there were five distinct sections: I. Theory and Measurements; II. Heavy Electric Current Appliances; III. Signalling, Telegraphy and Telephony; IV. Electrochemistry and its Special Applications; and V. Laws of the State Affecting Electrical Enterprise.

The papers of Professors Kohlrausch and Thompson belonged to Section I. The same afternoon in Section III. Dr. Strecker read a paper on "The application of Electricity to Ships." He criticised the English methods which are supposed to avoid the influence of electric machinery upon ship's compasses, and then he referred to electrical signalling in the British Navy. Dr. Strecker then described several systems, among which was that of Mr. Selluro (an Austrian naval officer) which is supposed to satisfy all the practical and necessary requirements.

Mr. W. H. Preece read a paper on "The Progress of Telegraphy and Telephony in England," which is published in this issue. Although delivered in English the whole paper had been translated into German, printed and distributed among the members present. The translating and printing was done at the suggestion and cost of Mr. Preece, and it ought to have set an example to the Germans, the majority of whom do not even write the papers, but deliver extempore, a proceeding which retards publication

and gives rise to errors in reporting. Mr. Preece sketched the advance in the speed of telegraphy from the time of Cooke and Wheatstone in 1852, when it was only possible to send 10 words per minute, to the present day, when 600 words per minute are sent through each wire. Then only half one message could be sent through a wire at one time. Now six distinct messages are sent simultaneously. Successful telegraphy depends upon exactness and speed. A telegram can be sent between any two places in England, be sent off and a reply received within half an hour, provided that the receiver of the message resides near a telegraph office. The influence of this rapidity in sending mesages is shown in the growth of the local telegraph business in the country. The total number of telegrams of the local traffic rose from 465,879 in the year 1871, to 2,171,516 in 1885. Then the sixpenny tariff was introduced, and the number of messages rose to 3,635,432 in 1886. It amounted to 5,714,675 in 1890. During the first year of the sixpenny telegram the mean value of an inland telegram came to 8½d., but it diminished gradually every year, and it is now somewhat less than 8d. Mr. Preece gave a number of statistics which proved of great interest to the Congress, and he concluded his paper by a criticism upon the British telephone business, and he said that Englishmen are ashamed of it. A discussion followed in which Mr. Grawinkel of Berlin, Dr. Julius Maier of London, and Mr. A. R. Bennett, of London, took part.

In Section II., Mr. Geist read a paper on "An Electrical Arrangement for Measuring Horse-power," but this method is well known, and has long been applied in England.

The paper on "The present Status of Measuring Instruments," by Dr. Koepsel, offered little novelty.

Dr. Lindeck lectured upon "Standand Cells," and related experiences with the standard cells of Clarke, Daniell and Fleming.

This busy day was concluded by the Congress attending the special performance, in the Victoria Theatre, of the ballet, "Pandora," in which electrical displays form an interesting part, and afterwards a supper at which complimentary speeches were given.

NEW PATENTS—1891.

14,663. "Improvements in couplings for connecting electric wires." A. SHIELS. Dated August 31st.

14,702. "Improvements in or connected with accumulators or secondary batteries." H. HAUSER. Dated August 31st.

14,752. "Improvements in appliances for use with incandescence lamps." A. HEALD. Dated September 1st.

14,754. "New or improved apparatus for electrically indicating the overheating of bearings." B. P. SCATTERGOOD. Dated September 1st.

14,764. "Improvements in armatures for dynamo-electric generators and electric motors." W. P. THOMPSON. (Communicated by J. F. McLaughlin, United States.) Dated September 1st. *(Complete.)*

14,768. "Improvements in lightning arresters." W. P. THOMPSON. (Communicated by J. P. Freeman, United States.) Dated September 1st. *(Complete.)*

14,780. "Improvements relating to telegraphy." B. B. TOYE. Dated September 1st.

14,786. "Improvements in electrical combs." J. M. RILEY. Dated September 1st. *(Complete.)*

14,790. "Improvements in electrical switches." W. P. ADAMS. Dated September 1st.

14,794. "Improvements in percussion drills and other percussion tools worked by electricity." SIEMENS BROS. & Co., LTD. (Communicated by Siemens and Halske, Germany.) Dated September 1st.

14,796. "Electric meter for continuous or alternating currents, also applicable as speed indicator and speed regulator." C. D. ABEL. (Communicated by La Compagnie Anonyme Continentale pour la fabrication des Compteurs à Gaz et autres appareils, France.) Dated September 1st. *(Complete.)*

14,800. "Improvements in and relating to electric metal working apparatus." H. H. LAKE. (Communicated by H. Lemp, United States.) Dated September 1st.

14,817. "Improvements in and connected with electric tramcars." W. E. HEYS. (Communicated by C. Brown, France.) Dated September 2nd.

14,834. "Improvements in and connected with electrically-propelled vehicles." W. E. HEYS. (Communicated by C. Brown, France.) Dated September 2nd.

14,854. "Improvements in materials for insulating electrical conducting wires, and for making carbons and incandescent filaments for electric lighting." G. A. CANNOT. Dated September 2nd.

14,859. "An improvement in incandescent electric lamps." E. A. GIMINGHAM. Dated September 2nd.

14,874. "An improvement in electric light switches." R. H. NEWINGTON and E. PRIDDLE. Dated September 3rd.

14,911. "Telephone receiver supports." W. N. MARCUS. Dated September 3rd. *(Complete.)* [Date applied for under Patents Act, 1883, Sec. 102. 10th February, 1891, being date of application in United States.]

14,912. "Telephone mouth pieces." W. N. MARCUS. Dated September 3rd. *(Complete.)* [Date applied for under Patents Act, 1883, Sec. 103. 10th February, 1891, being date of application in United States.]

14,916. "Improvements in magnetic separators." T. W. ARNOLD. Dated September 3rd.

14,920. "Improvements in insulators for telegraph and other wires." K. SCHMAUS. Dated September 3rd.

14,962. "Improvements relating to telephones." W. H. BROWN. Dated September 4th. *(Complete.)*

14,967. "Improved process and apparatus for extracting aluminium and its alloys by electrolysis." G. STEINLE. Dated September 4th.

14,987. "Improved electrical drill." SIEMENS BROS. & Co. LTD., A. H. DYKES and F. G. BAILY. Dated September 4th.

15,014. "An improved electric belt or band." W. N. NAYLOR. Dated September 5th.

15,025. "An improved apparatus for propelling one or more imitation birds by electricity for shooting at." A. MCLEAN GORDON and E. K. IRWIN. Dated September 5th.

15,050. "Improvements in or connected with electrolysis." E. A. LE SUEUR. Dated September 5th.

15,051. "Improvements in medical electric appliances." C. S. STOVIN. Dated September 5th.

15,052. "Improvements in medical electric appliances." C. S. STOVIN. Dated September 5th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

7,725. "Electric switches." C. E. CHALLIS and G. GRAHAM. Dated May 17th. 6d. The inventors lessen the sparking ordinarily taking place at making contact, and eliminate the danger of the switches being left "half on" by causing the contact to be made by a "fly-on" movement, and broken by a "fly-off," which are practically instantaneous. 1 claim.

9,602. "Improvements in the distribution of electrical energy." SIEMENS BROTHERS & Co., LIMITED. (Communicated from abroad by Messrs. Siemens and Halske, of Berlin.) Dated June 20th. 8d. Claims:—1. In the distribution of electrical energy by means of alternating currents, the combination of a rotary transformer with the alternate current generator, the main distributing circuit and with accumulator batteries in such manner that both the charging and the discharging of the accumulator batteries is effected through the medium of the rotary transformer, this being made to convert the alternating current from the central station into a continuous current for charging the accumulator batteries, while on the other hand the continuous current received by the rotary transformer from the charged accumulator batteries is transformed thereby into alternating currents which are conveyed into the main circuit, substantially as described. 2. In the distribution of electrical energy by means of alternating currents, the combination of an alternate current generator supplying the distributing circuit directly with alternating currents, a rotary transformer connected in parallel to the distributing circuit, and accumulator batteries which are charged through the transformer, and the current from which, when charged, passes through the rotary transformer into the distributing circuit, substantially as described.

9,683. "Improvements in electrically driven percussive tools and in the means of operating the same." L. B. ATKINSON. Dated June 21st. 8d. Consists in constructing such percussive tools in such a manner that a reciprocating or oscillating movement is obtained directly from the action, and reaction of magnetic fields, instead of from a revolving electrical motor producing the reciprocating action by mechanical means, such as cranks, or cams, as is at present known. 8 claims.

11,817. "Improvements in electric light fixtures." F. H. ALDRICH. Dated July 29th. 8d. Has for its object to provide a fixture which shall enable an incandescent light of ordinary construction to be conveniently adjusted and locked in the adjusted position. 7 claims.

11,862. "Improvements in electrostatic measuring instruments." W. E. AYRTON and T. MATHER. Dated July 29th. 8d. Consists, first, in making the fixed and movable parts of the instruments of certain definite forms and placing them in certain definite relative positions so as to obtain an instrument having great sensibility, or a long range with fair proportionality between the deflection and the electrical magnitude measured, or so as to obtain an instrument with a short or with a long range, but which is especially sensitive at that part of the scale about which it is intended to be used. Relates, secondly, to improved methods of making and fitting together the parts of the movable system of such instruments so as to obtain good electrical contact between these parts, as well as when required between the movable system and some portion of the fixed system, and, thirdly, to the combination of such electrostatic measuring instruments with resistances and capacities, for the purposes specified. 5 claims.

12,915. "Improvements in brush holders for dynamo-electric motors and generators." A. J. JARMAN. Dated August 18th. 8d. Has for its objects a perfectly elastic contact with the commutator. 4 claims.

13,129. "Improvements in safety fuses or cut-outs for electrical circuits." A. W. SLATER. Dated August 21st. 8d. Claims:—1. The construction of a cut-out or safety fuse for electric circuits in which the fuse wire is carried by two split rods or prongs, and passes through a hole in each, and is gripped in the holes when the prongs are closed by being inserted into metal tubes to which the circuit wires are connected, substantially as described. 2. The construction of a cut-out in which the metal parts carrying current, except the fuse wire and its supports, are embedded in a block of insulating material, and the manner of securing the said metal parts in position by dividing the block horizontally into two portions, substantially as described. 3. The construction of a group of cut-outs or distributing board, substantially as described.

13,232. "Improvements in magnetic separators." W. L. WISE. (A communication from abroad by G. S. Finney, of Chicago.) Dated August 22nd. 11d. Relates particularly to improvements in the class of magnetic separators in which are employed a magnetic wheel and an endless belt of non-magnetic material surrounding the wheel and serving to support the material while being treated. 18 claims.

13,256. "Improvements in coin-freed electrical apparatus." J. T. GENT, A. W. STAVELEY, and I. H. PARSONS. Dated August 22nd. 8d. Relates to a novel apparatus, consisting of a figure or group of figures, the different parts or organs of which are made movable, and so arranged that on a coin of predetermined value being dropped into the apparatus, or into any receptacle communicating with the apparatus, and any two parts or organs being grasped or touched by a person desiring to make use of the apparatus, the electric circuit will be completed, and the strength of the current indicated. 3 claims.

13,260. "Improved means for the distribution of electricity." M. VON DOLIVO-DOBROWOLSKY and P. MAMROTH. Dated August 22nd. 8d. Consists in so connecting the coils with one another that the resulting electromotive forces are actually connected in series, and then connecting together the n groups of coils of the armature at one of their ends at a common point and connecting a conductor at this point, the other end of each group of coils being connected with the main conductors. 4 claims.

13,358. "Improvements in the means for driving winches and other winding machinery by electrical motors." A. SIEMENS. Dated August 25th. 6d. The inventor arranges the motor either with its armature shaft in a vertical or inclined position below the deck on which the winch is fixed, or he arranges the same on the same level with the winch with the armature shaft horizontal, in which case he encloses it in a suitable watertight casing, through a stuffing box on which the armature shaft projects. This shaft is connected either directly or through an intermediate shaft and coupling allowing a certain amount of longitudinal and lateral play, with the first motion shaft of the winch by suitable bevil or spur toothed gearing. 1 claim.

13,359. "Improved means for carrying electro-motors on electrically-propelled cars or vehicles." SIEMENS BROTHERS AND COMPANY, LIMITED. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated August 25th. 8d. Consists in carrying the electro-motor for propelling the vehicle in such a manner upon a framing situated between the axles of the running wheels, as to be independent of the body of the vehicle, and so that the supports of the motor have spring action, while free angular movement is afforded to the wheel axles. 2 claims.

14,844. "An improved electrical connector." J. APPLETON and E. L. JOSEPH. Dated September 19th. 8d. The portion of the connector, which is attached to the wall, or other support, consists of a block of earthenware, or other suitable material, having a boss projecting from the centre thereof. Two terminal contact plates are situated one on either side of the said boss, with their contact faces parallel with the before-mentioned flats. The main wires, or conductors, are connected in the usual manner to these terminal contact plates, and a safety fuse may also be provided if desired. A cap or cover plate, having a central hole of a diameter approximately the same as that of the beforementioned central projecting boss, is adapted to screw on to the fixed portion of the connector in such a manner that the outer end of the said boss projects slightly through the central hole of the cap or cover plate. The portion of the connector which is attached to the free ends of the wires or conductors of the portable lamp, or other apparatus, consists of a cap of earthenware, or other suitable material, into the interior of which is screwed an ebonite or other disc to which are attached two outwardly projecting terminal contact plates which are adapted to be pressed more or less tightly between the surfaces of the flats formed on the beforementioned central boss and the two terminal contact plates of the fixed portion of the connector. The free ends of the wires or conductors of the portable lamp, or other apparatus, are passed through a hole or holes in the earthenware cap, and are attached to the terminal contact plates in the usual manner. 2 claims.

15,442. "An artificial ground and compound metallic circuit system for electric telephones and the like." C. E. MCCLUER. Dated September 30th. 8d. Furnishes a system of "compound metallic circuits" which can readily be adopted as a substitute to the ordinary two wire metallic circuits and applied to any existing exchange system or switchboard without any inconvenient and objectionable multiplication of wires, and without change whatever in either the switchboard, or switchboard methods or connections beyond the simple substitution, of the "artificial ground" connections in place of the usual earth connections, and yet afford all the immunity from interference from extraneous currents leaking from the earth secured by the adoption of the ordinary "two wire metallic circuits," and at but a small fraction of their cost. 4 claims.

CORRESPONDENCE.

Telephone Development.

Last week, in dealing with the paper by Mr. A. R. Bennett on the telephoning of great cities, you briefly referred to the new telephone company which is now in process of formation, and which will, it is said, shortly enter the field of direct competition with the National Telephone Company in London, with very strong financial support.

It has been said, and with some reason, that the telephone system of London is a disgrace to the largest and most important city of the world, and though the existence of two rival companies may cause some temporary inconvenience, the evils resulting from the present monopoly are so apparent, and the day for their disappearance, should the monopoly continue, is seemingly so remote, that one cannot but have some sympathy with the aims of the new venture, feeling sure that, so far as lower rates, improved service, and the requirements of the public generally are concerned, little but good can eventually come of competition.

It is stated in the Duke of Marlborough's interesting letters to the *Times* that it is proposed to promote a Bill before Parliament next session for the purpose of obtaining power for the new company to lay their wires underground throughout the metropolis, and, should the company be successful in this, it is obvious that its position will be a very strong one.

The National Company has, of course, in its favour the fact that it is a fully organised going concern, with much accumulated experience and a long purse; but though since the date of the amalgamation the service has certainly improved, sufficient time has not yet elapsed for the public to forget the gross mismanagement and high-handed proceedings of the past, and even now the company cannot be said to possess the goodwill of the larger portion, at any rate, of its subscribers. Its chief strength, now that the Edison and Bell patents have expired, lies perhaps in the way-leaves that it possesses all over London, but if a rival company should obtain Parliamentary power to run everywhere underground, this advantage will become greatly lessened. No doubt the National Company might follow suit; in fact, were it once proved to the public that the hideous disfigurement of overhead wires was unnecessary, it would very probably be compelled to do so; but then, what would become of all the overhead plant, on which so much labour and money have been expended?

Moreover, it is now universally admitted that on any extensive scale, and in a large town like London, there is only one system by which it is possible to eliminate the disturbing effects of induction, and arrive at any near approach to perfect communication. Metallic circuits without earth returns are a *sine quâ non*. A new company will be able to adopt this arrangement from the start without much extra cost, but in the case of the National it would mean the entire reorganisation of the whole of their system of wires, and in many cases, entirely new exchange apparatus. The fact is, however, that sooner or later the National Company will, in any event, have to face both the question of putting its wires underground and that of metallic circuits. The first practically follows as a corollary of the second, as in any extensive scale, it will be found impracticable to employ the metallic circuit arrangement, except with wires laid underground. The alterations will imply a very serious expenditure, which will only prove more heavy the longer it is put off. Again, there is the question of telephonic instruments. Great improvement, as was the Blake transmitters on the original Edison carbon telphone, and fairly well adapted as it may yet be for short lines, no one can pretend that it is now the best instrument obtainable for exchange work, or for use over long distances. There are others of greater simplicity and less cost, which have not the same liability to get out of adjustment, and which will admit of more battery force being employed with consequent increase of power. The same thing may be said of the single pole Bell receiver, in comparison with its numerous rivals of more recent date. Any one who has ever had occasion to compare the working of a set of the Gower-Bell instruments, as used by the Post Office with the Bell-Blake combination, will fully recognise the difference. Here, again, therefore, is a further opportunity for the new company. The existing system is supplied throughout with instruments of a somewhat antiquated type,

and it would require a large expenditure to renew them, but a new company will be in a position to select the very best and most improved instruments that there are.

The National is already weighted with an immense capital of some £3,000,000 sterling, much of which has been expended in patents which have expired, and on plant which has become obsolete, or which has been added as "water" at various periods, when subsidiary companies were promoted or re-absorbed by amalgamation. In fact Mr. A. A. C. Swinton, in the *Times*, has gone so far as to suggest that of the £1,250,000 which he gives as the proportion of capital that was paid by the National to the United Company for the London business, nearly £1,000,000 is "water," pure and simple, and that were this vast sum written off and the interest at present being earned on it, applied to the reduction of the London subscription rates, the latter might be brought down to not much over £8 per annum without lowering the rate of profit on the remaining capital, *i.e.*, on that which actually represents the value of the plant. It is fair to mention that Mr. Faithfull Begg, writing to the *Times* on behalf of the National Company, attempts to controvert in some degree this conclusion, but that the process of "watering" has taken place to a very large extent in connection with the London business is undoubted. The National Company is at present able to pay a very respectable dividend on its immense capital, but whether it will be in a position to continue to do so when under the influence of strong competition, is a very different question, and is one that, should such competition arise, must afford serious grounds for reflection on the part of those immediately concerned.

No doubt the new company will have serious problems to grapple with. As was said in your article of last week, the telephoning of great cities is a question requiring grave consideration, and to enter into direct competition with an established and powerful organisation, such as the National Telephone Company, is an undertaking not to be entered into with a light heart. Much will depend on the question of finances, much on the engineering, much on the general management.

It has been assumed that the new company will commence operations on the lines of the scheme propounded by Mr. A. R. Bennett before the British Association. This scheme you have not hesitated to criticise, and as it is improbable that the new company have yet come to any definite decision as to the precise details of the system that they will adopt, such criticism should be welcomed.

As you have stated, the telephoning of great cities is a fine problem and it is to be hoped, therefore, that when the new company gets beyond the stage of newspaper discussion, and proceeds to actual operations, it will do so on a plan that will prove worthy of the occasion; it is indeed a great opportunity.

Whether the new company succeeds in itself in giving a telephone system commensurate with the size and importance of the Metropolis, or whether by force of competition it compels the National company to do so in self-defence, will not signify much to the public, so long as this much-to-be-desired result is itself obtained.

Telephonist.

Railway Accidents for the year 1890.

Referring to the above article in your issue of September 4th, will you be so good as to allow us to correct a statement made therein with regard to the system of electrical interlocking of the block telegraph instruments with the out-of-door signals of railways, or, perhaps, more properly speaking, the "unlocking of signals by electricity."

Nearly at the top of page 266 it states: "In all cases, but that of the Midland Railway Company, it is true that the interlocking arrangements involve new block instruments." This is not so; we have, as manufacturers of Mr. C. E. Spagnoletti's system, which has been working on the Metropolitan Railway for the last nine years, attached his electrical locking system to all the block instruments, which have been in work for 26 years on that railway, and also to some on the Great Western Railway. The Metropolitan Railway Company are now having the whole of their line completed with this system, and it is so adaptable that it can be applied to any block telegraph instrument extant without any difficulty. The heavy traffic on the Metropolitan Railway is a hard and severe test of any system, and about 20 million operations every year have to be gone through, and the failures are about 1 in 1 million operations; but it should be clearly understood that any failure that may happen is on the side of safety, locking up the signals; and these failures are easily removed if they do occur (until the fault is rectified) by the station master or inspector, doing by hand what the train on arriving should do automatically, after communicating to the next station by the speaking telegraph, and still retaining the safety of electrical locking, so that, under these circumstances, the chances of accident are reduced to a minimum.

One late and valuable addition has been made to this system, viz., its application for protecting trains while crossing or shunting from one road to the other, or to and from sidings, and to trains while standing on the wrong line. This is what has been so long required, and we feel sure that this method has only to be understood by railway managers to be adopted at junctions and exceptional places, as it is simple, perfect, and not expensive.

Your excellent article will, we hope, do much to bring the system of electric interlocking of the block telegraph with the out-of-door signals to the front, or to introduce the system of electrical locking itself, without the block system, as it is in itself a locking and blocking system. It is more expensive to apply it to the existing block systems, both as regards the apparatus and the number of wires required to work a duplicate system. The block system takes three wires, and the locking one, so that four wires have to be maintained and two sets of apparatus with batteries. By working the electrical locking by a separate instrument three wires can be dispensed with, or if it is preferred to have a two wire locking system, then two wires are saved and can be used for other purposes. A more detailed system can be obtained by the combination, as the more wires you have the more you can do; however, there can be no doubt that the introduction of such a system would conduce to the safer working of railways, and fill the loopholes which still exist in our already excellent system of railway working and which allow unfortunate results to sometimes creep in, in spite of all the care and consideration bestowed upon the regulations. What we now want is to check the fallability of human agents, and this the electrical locking does effectually.

J. E. Spagnoletti & Crookes.

Who Invented Magnetic Needles and Insulated Wire?

For some time past I have been trying to ascertain who first gave the world magnetised steel needles, and to whom belongs the honour of first insulating wire.

So far as my limited search here will admit, Robert Norman, of London, made a speciality of supplying such needles for compasses; whilst Prof. "Schweigger" seems to have used wire covered with cotton, or silk, for his "Multiplier" or galvanometer, in 1822. Yet Sturgeon in 1825 was not aware of how to insulate wire, or he never would have made his electro-magnets of *bare* copper, of one layer only. The first thing Prof. Henry, of America, did to improve the electro-magnet, was to use insulated wire. As the above two links are missing in the "Chronology of Applied Electricity," in Whittaker, and also from the later "Chronological History of Electricity," by Mottelay, perhaps you, or your readers, can definitely decide both time and individuals, and thereby confer a benefit upon a few besides

Sam. Vyle.

Georgetown, Demerara.

Electric Motors.

IN answer to a query in your last issue respecting a small electric motor, exhibited in the Edinburgh Electrical Exhibition, 1890, which worked without a commutator, I beg to state that the only one so exhibited was by Mr. Rankin Kennedy, of Carntyne Electric Works, Shettleston, Glasgow. It was an alternating current motor, with two armatures, wound on the same spindle, revolving in two distinct magnetic fields.

L. M. Waterhouse, A.I.E.E.

Lightning Arresters.

Seeing a letter in your paper, dated September 4th, referring to lightning and lightning arresters, I daresay some of the readers of the above would be interested to hear the following account of a flash of lightning which struck our wires.

About two weeks ago, while I was sitting in my office, facing the window, I saw a tremendous flash of lightning, and almost at the same time I heard a loud cracking in the dynamo room, so I got up and examined the lightning arresters, which I found a little warm; they are of the Thomson-Houston pattern. Nothing else showed any signs of lightning entering the building. The next thing I did was to examine the circuits, which are four in number, and on one of them I found 14 successive lamps, about a mile off from the station, had got their fuses pierced, showing that the flash had struck the overhead wires, pierced the fuses, being the shortest route, and followed the wires to the station till it got to the arresters, it was then conducted to earth without doing any damage to anybody or anything. I have further examined the arresters and cannot find any trace of damage to them; they are in as good order now as they were before the flash.

Percy Mossop,

Superintendent of Weybridge Electric Light Company, Limited, Weybridge.

September 11th, 1891.

Notes on Microphones.

I would be obliged by your kindly allowing me a small space in this issue of your paper, in order to make a few comments on the article, "Notes on Microphones," in your last.

Highly appreciable as the intention of the writer may have been to promote the cause of telephony, he has, perhaps, in several points subjected himself to the criticism of some of your readers.

It is generally admitted that the telephone system in London is not all that can be desired, but it must not be believed that the monopoly in telephones hitherto has been an obstacle in the way of improvements. On the contrary, the manufacturers (the Consolidated Telephone Construction and Maintenance Company, Limited), not having been forced to run their prices down in competition, have had ample opportunity to devote time and energy to the improvement of their goods.

The decision of the G.P.O. to use one of their instruments, the "Gower-Bell," on the London-Paris line, is sufficient proof for the aforesaid. No better telephone was found in the markets of the world, all countries, I believe, having been drawn upon when the tests were made.

As regards the theoretical and more important part of the article, telephones are (or should be) generally fitted up in dry places, such as offices or rooms, in which there is, practically speaking, an even temperature throughout the winter. Under these circumstances the weather does not affect the *microphones* so much as the writer may have thought, but it raises the *capacity* of the line, our bitterest foe in telephone engineering, and thereby prejudices good transmission of sound.

The use of brass clamps instead of damping springs, India-rubber or other elastic material, is certainly a very good device. This same principle, only of a somewhat different appearance, has been adopted for a considerable number of years in the Consolidated telephone, and has proved to be a complete success. But as for using cork for damping the vibration of the carbon pencils, I think this is too porous a material and one that will readily take up moisture. Thus by expanding or contracting, however little, the adjustment of the carbons would be influenced.

A much simpler and a very good means for attaining the same purpose, *i.e.*, for damping the vibration, is to make the diaphragm stouter in the centre, say ½-inch radius from the centre, and tapering towards the edge (or having a second small diaphragm of ½-inch radius underneath the ordinary one), the carbon blocks being fixed to the diaphragm by two brass screws. I found by experiments that—having a certain amount of space between the two carbon pencils and the diaphragm—the instruments talked equally well in a vertical, horizontal, or slanting position. This amount of space was sufficiently large to prevent the carbon pencils from touching the diaphragm, whatever position the microphone was placed in.

It is manifest that the avoidance of any material which would lead to faults, must be of advantage to both the manufacturer and the user.

Max Salmony.

September 14th, 1891.

A New Method of Galvanometer Suspension.

While experimenting with a home-made astatic mirror galvanometer, it occurred to me to use a fine steel wire for the connection between the needles, and suspend it from the point of a magnetised "darning" needle. The result was unexpectedly successful; for after a little adjustment the arrangement was sufficiently delicate to give a deflection of 3 inches with 1·9 volts through 750,000 ohms, the scale being 50 inches from the mirror. The coil was composed of about 1,500 turns round the lower needle. To obtain success, the strength of the supporting magnet must be just sufficient to overcome the force of gravity on the needles; the points of contact must be smooth and *fine*, and the magnet must be truly vertical.

The advantages of the arrangement are: a perfectly constant zero, inappreciable friction, saving of time both in mounting and in the avoidance of broken silk suspensions, and perfect portability.

I do not suppose that this method will supplant silk and quartz fibres in laboratory instruments; but I hope it will be of use to those who, like myself, occasionally experiment with home-made apparatus.

A. H. Allen.

Telephonic Action.

In a note on my short article in your last week's issue, anent the influence of the resistance and self-induction of telephonic instruments themselves, you demur to one of my conclusions and observe:—

"Now, it is well known that a resistance coil wound singly, an induction coil, in fact, without the iron core, even of very high resistance, has very little effect in cutting down the speaking, because of the mutual induction between the turns of wire; it is only when the iron core comes to be inserted that a 'plugging' effect is produced."

I cannot, however, agree with you in this. In a single coil traversed by an alternating current, the induction which takes place between the turns has a retarding effect on the current, nor does the addition of iron in the core of the coil reverse the conditions, it only intensifies them.

That my statements are in accordance with facts, can be shown by the following experiments.

A battery is joined up to the primary of a small induction coil, and the vibrator arranged to give a high note. A Bell receiver is placed in the secondary circuit with an arrangement for throwing in and out of the circuit either of two resistances.

The first, a non-inductive resistance of 2,000 ohms.

The second, a singly wound coil on a boxwood bobbin without iron core, having an ohmic resistance of 2,000 as the first coil.

Either resistance can also be cut out of the telephone circuit, so that the effect of its addition can be seen.

Now, taking the addition of 2,000 ohms to the circuit whichever coil is employed, the loudness of the note given by the telephone is most materially reduced.

Next, on trying the relative effect of the non-inductive and inductive resistances, the loudness of the note given by the telephone is distinctly less with the latter than with the former.

It should be noted that the coils in the two sets of telephonic instruments at the ends of a line have iron cores.

An ordinary coil without iron core has not much effect in cutting down speech, for I think the reasons I gave, namely, that the resistances, ohmic and inductive, already in circuit are large.

G. L. Addenbrooke.

September 14th, 1891.